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ANNALS
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NOTES ON COLORADO APHIDIDÆ.

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This paper deals primarily with new species of *Aphididæ* on *Artemisia*, with notes from type slides of some described species on the same host, in the hope of clearing up some confusion and correcting typographical errors in literature. Three hitherto undescribed species on *Populus*, *Valeriana* and *Pedicularis*, respectively, have been added.

Acknowledgments are due to Dr. P. W. Mason, Myron H. Swenk and A. A. Granovsky for their kindness in loaning type slides for examination.

Macrosiphum longipes, n. sp.

Apterous Viviparous Female.—(Plate I, Fig. 2; Plate II, Figs. 1 and 2). Described from 23 examples taken on *Artemisia tridentata* near Log Cabin, Colo., July 30, 1926.

Color: Paris green, covered with an even coating of white powdery secretion over entire dorsum, corresponding very closely to the color of the host plant, which also has frosted appearance; cauda dusky green; legs black, except proximal one-fourth of femora; antennæ black throughout, except base of joint III, which is dusky greenish; cornicles black; eyes red.

Measurements: Body, 2.56 mm. in length to base of cauda, by 1 mm. in width; hind tibiæ 2.5 to 3 mm.; antennæ, 4.70 to 5.30 mm.; joints: III, .99 to 1.16 mm.; IV, 1.03 to 1.23 mm.; V, .90 to 1.05 mm.; VI, .20+1.12 to 1.45 mm.; cornicles, .86 to 1.15 mm.; cauda, .30 mm.

Morphological Characters: Secondary sensoria on joint III of antenna, 0 to 2; hairs slightly capitate, on antennæ fairly numerous, .04 mm. long; on body sparse, .07 mm. long; on tibiæ fairly numerous, .07 mm. long; on cornicles 2 to 5 on proximal half; hairs on cauda pointed, hardly curved, 2 to 3 on each side; cornicles imbricate, hardly reticulate at distal end, slender, slightly enlarged at distal end, flange

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very small and set at a slant; cauda triangular without constriction near base; frontal tubercles well developed; ocular tubercles not evident.

Alate Viviparous Female.—(Plate I, Fig. 1; Plate II, Figs. 3 and 4). Described from two examples taken in same collection as apterous forms above described.

Color: Abdomen same as apterous, head and thorax brown, covered with light coating of white pulverulence; cauda greenish brown; legs black except bases of femora, which are dusky yellowish; antennæ black throughout except basal two joints brownish; cornicles black; stigmas dusky brownish; veins bordered with brown.

Measurements: Body to base of cauda, 2.40 mm.; wings, 3.30 mm. long; hind tibiæ, 2.60 mm.; antennæ, 5 mm.; joints: III, 1.05 to 1.10 mm.; IV, 1.10 to 1.24 mm.; V, .90 to 1.02 mm.; VI, .20+1.45 mm.; cornicles, 1 mm.; cauda, .26 mm.

Morphological Characters: Secondary sensoria 1 to 12 on basal half of joint III; hairs as in apterous; wing venation normal; cornicles, cauda and eyes as in apterous.

Collections all on *Artemisia tridentata* at Estes Park, Log Cabin and North Park, Colorado, by C. R. Jones and the authors.

Apterous Viviparous Female. Three collections, from July 30 to August 26.

Alate Viviparous Female. One collection, July 30.

Macrosiphum glabrum, n. sp.

Apterous Viviparous Female.—(Plate I, Fig. 3; Plate II, Figs 5 and 6). Described from 14 examples taken on *Artemisia dracunculoides,* near Log Cabin, Colo., July 30, 1926.

Color: Dorsum shining shamrock green, corresponding closely to the color of the host plant, which is also glabrous; legs black except bases of femora, which are greenish; antennæ black except joints I and II and base of III; cornicles black; cauda dusky greenish yellow.

Measurements: Body to base of cauda, 2.3 mm. in length by 1 mm. in width; hind tibiæ, 1.60 to 2 mm.; antennæ, 3 to 3.2 mm.; joints as follows: III, .60 to .70 mm.; IV, .60 to .70 mm.; V, .52 to .60 mm.; VI, .19 to .23 + .60 to .70 mm.; cornicles, .55 to .60 mm.; cauda, .23 to .30 mm.

Morphological Characters: Secondary sensoria 2 to 5 on joint III of antenna; hairs on body, antennæ and legs slightly capitate, .04 mm. long, on cauda, pointed, about .07 mm. long, and slightly curved, 3 to 4 on each side of cauda; cornicles reticulated for nearly distal half, almost cylindrical, slightly broader at base; cauda conical, without constriction at base; frontal tubercles well developed; ocular tubercles present.

Alate Viviparous Female.—(Plate I, Fig. 4; Plate II, Figs. 7 and 8). Described from four examples taken in same collection as apterous examples described above.

Color: Head and thorax dusky greenish, abdomen and appendages same color as in apterous; stigmas pale brownish yellow, wings hyaline, veins light brown.

Measurements: Body to base of cauda, 1.80 mm.; hind tibiæ, 1.80 mm.; antennæ, 3 mm.; joints: III, .65 to .70 mm.; IV, .63 to .76 mm.; V, .50 to .64 mm.; VI, .21+.80 to .92 mm.; cornicles, .45 to .55 mm.; cauda, .30 mm.

Morphological characters: Secondary sensoria 10 to 15 on joint III; medias twice branched, hind wing with two cross veins; hairs, cornicles and frontal tubercles as in apterous described above.

Several examples were taken of what seems to be a small variety of this species with measurements about two-thirds of those of the prevailing form. There seem to be no good characters, however, upon which to establish another species.

Only one collection taken besides the types, all alate viviparous females, on *Artemisia dracunculoides* at Fort Collins, Colorado, May 17, 1915.

Macrosiphoniella frigidicola, n. sp.

Fundatrix. Described from a single specimen taken May 30, 1921, above Bellvue, Larimer County, Colo.; altitude 8,000 feet. Same in color and general appearance as the summer apterous viviparæ, but slightly stouter in form, and the antennal joints and legs are somewhat shorter.

Measurements: Body 1.6 mm. long by 1 mm. wide; antennæ, 1.6 mm.; joints as follows: III, .45 mm.; IV, .28 mm.; V, .28 mm.; VI, .12+.37 mm.; joint III with 3 to 4 secondary sensoria; hind tibiæ, .95 mm.; all other characters as in apterous viviparous female.

Apterous Viviparous Female.—(Plate I, Fig. 5, and Plate II, Figs. 10, 11 and 12). Described from four examples taken with numerous others October 4, 1917, at Fort Collins, Colo., by L. C. Bragg.

Color: Greenish glaucous or sea-green, varying to dark greenish glaucous with slight pulverulence, coinciding very closely with the color of the host plant; slightly brownish on head; legs brownish yellow, with tarsi, tips of tibiæ, knees and distal half of femora dusky to blackish; antennæ dark dusky to black, except proximal half or two-thirds of joint III, which is pale orange; cornicles dark brownish to black; eyes reddish; cauda dusky.

Measurements: Body, 1.7 mm. long by .86 mm. wide; antennæ, 2.2 mm., slightly exceeding length of body; joint III, .42 to .55 mm.; IV, .38 to .55 mm.; V, .36 to .54 mm.; VI, .18 to .20+.65 to .76 mm.; cornicle, .20 to .32 mm.; hind tibiæ, 1.2 to 1.6 mm.; cauda, 2.5 mm.

Morphological Characters: Secondary sensoria on joint III, 3 to 6 in number; hairs blunt, sparsely distributed on body and antennæ, fairly numerous on legs; cornicles cylindrical, coarsely reticulated for more than distal half, eyes with ocular tubercles; cauda slightly constricted near base, bearing 4 or 5 hairs on each side and 2 or 3 on top.

Alate Viviparous Female.—(Plate I, Fig. 6; Plate II, Fig. 13). Described from 12 specimens taken at Idaho Springs, Colo., June 17, 1926.

Color: On abdomen same as apterous; head and thorax dusky brown to blackish; entire dorsum slightly pulverulent; cauda dusky; cornicles, entire legs and antennæ dusky to black throughout; stigmas brownish.

Measurements. Body, 2.3 mm.; antennæ, 2.6 mm.; joints of antennæ as follows: III, .60 to .70 mm.; IV, .48 to 66 mm.; V, .45 to .55 mm.; VI, .18 to .23+.55 to .77 mm.; cornicles same as in apterous; hind tibiæ, .45 mm.; cauda, .25 mm.; secondary sensoria on joint III, 14 to 17; medias twice branched.

Oviparous Female.—(Plate I, Fig. 8; Plate II, Fig. 15). Described from four examples taken October 5, 1917, along with apterous viviparæ at Fort Collins, by L. C. Bragg.

Characters the same as viviparæ, except that the abdomen is more elongate, 2.1 mm. in length by .86 mm. in width; cauda apparently broader and pinkish in color; hind tibiæ very slightly swollen on proximal third and bearing about 16 large flat sensoria.

Egg: .66 mm. by .3 mm., pale greenish yellow when first laid, turning black later, shining.

Apterous Male.—(Plate II, Fig. 14). Described from two males taken with above oviparæ.

Color: Light brownish to dusky brown, especially on prothorax and head; cauda dusky brown, all other appendages dusky to blackish.

Measurements: Body, 1.5 mm. by .51 mm.; antennæ, 2.3 mm.; joint III, .50 to .55 mm.; IV, .47 to .50 mm.; V, .39 to .43 mm.; VI, .18 + .63 to .68 mm.; cornicles, .15 mm.; hind tibiæ, 1.2 mm.; secondary sensoria on joint III, about 40; IV, about 30; V, about 14.

This species has been taken, with one exception, on stems and leaves of *Artemisia frigida*, only, but apterous specimens received from A. C. Baker, taken on *Artemisia abrotanum* Linn., seem to be of the same species. There is a superficial resemblance to *Macrosiphum ludovicianæ* Oest., in coloring especially, but the cornicles, cauda and antennal joints are much shorter, the sensoria much fewer in number, and the males are apterous instead of alate. Both species are often taken in the same locality and on plants growing side by side, but each on its own particular host. *Macrosiphoniella artemisiæ* Boyer, which might be confused with *frigidicola* can be separated from it by having 10 to 14 sensoria on joint III of apterous, and 22 to 30 on the same joint in the alate viviparous females, by having 6 to 8 hairs on each side of the cauda, and by occurring on *Artemisia vulgaris, absinthii* and *abrotaniella*. See "The Plant Lice or *Aphididæ* of Great Britain," Vol. I, p. 161, 1926, by Theobald.

Collections were taken in altitudes from 5,000 to 8,000 feet in northern Colorado, by L. C. Bragg and the writers as follows:

On *Artemisia frigida:*

Fundatrix. Single collection, May 30, in hills above Bellvue.*

Apterous Viviparous Female. Six collections from June 6 to October 4.

Alate Viviparous Female. Four collections from May 27 to September 19.

Sexuales. One large collection October 5.

On *Eurotia lanatum:*

Apterous Viviparous Female. One collection July 30.

Macrosiphum filifoliæ, n. sp.

Apterous Viviparous Female.—(Plate III, Fig. 5; Plate IV, Fig. 17). Described from 11 examples taken on *Artemisia filifolia* at Denver, Colorado, August 13, 1919.

Color: Cinnamon brown shading to amber brown tinged with yellow ocher† on the sides.; legs dusky to black, excepting proximal half to three-fourths of femora and proximal one-third of tibiæ distal of knee, which are pale ochraceous yellow; antennæ dusky to black except joints I and II and base of joint III, which are brownish to dusky; cornicles dusky to black.

Measurements: Body pyriform, 2.3 mm. in length by .50 mm. in width; hind tibiæ 1.26 mm.; antennæ, 2.25 mm.; joints of antennæ as follows: III, .52 to .67 mm.; IV, .36 to .52 mm.; V, .35 to .47 mm.; VI, .11 to .13 + .51 to .65 mm.; cauda, .40 mm.; cornicles, .60 to .70 mm., never shorter than filament of antenna, almost always distinctly longer.

Structural characters: Secondary sensoria on joint III only 3 to 8 in number; hairs on body, antennæ and legs, .05 mm. in length and slightly capitate, moderately numerous; cornicles bearing 6 to 8 hairs similar to those on body; cauda with pointed, slightly curved hairs, 12 in number; eyes with ocular tubercles; cornicles reticulated on distal one-eighth, rather stout and hardly enlarged at base; frontal tubercles moderately large and diverging.

Alate Viviparous Female.—(Plate III, Fig. 6; Plate IV, Figs. 18, 19 and 20). Described from 8 examples taken in collection with apterous viviparæ mentioned above.

Color: Cinnamon brown on body, legs dusky to black, except bases of femora, which are pale ochraceous yellow; antennæ dusky to black, except base of joint III which is pale yellowish, and joints I and II which are brownish; stigmas pale dusky yellow.

Measurements: Length of body, 2 mm.; length of wings, 3.2 mm.; hind tibiæ, 1.4 mm.; antennæ, 2.7 mm.; joint III, .60 to .72 mm.; IV,

* Altitude, 8,000 feet.

† In other collections some examples of a greenish yellow color were seen.

.45 to .52 mm.; V, .40 to .50 mm.; VI, .10 to .15 + .51 to .65 mm.; cornicles, .55 mm.; cauda, .30 mm.

Structural characters: Secondary sensoria present; on joint III, 11 to 22; absent on IV and V; hairs, cornicles and frontal tubercles as in apterous.

Collections were made by L. C. Bragg as follows:

Apterous Viviparous Female, on *Artemisia filifolia*, three collections, Greeley and Denver, June 20 to July 15.

On *Artemisia vulgaris*, one collection, Fort Collins, Colorado, September 18.

Alate Viviparous Female, on *Artemisia filifolia*, three collections, June 20 to August 12; on *Artemisia vulgaris*, one collection, Fort Collins, Colorado, September 8, 1919.

This species has been taken only on *Artemisia filifolia*, except one record on *Artemisia vulgaris*. It resembles *Macrosiphum coweni* Hunter very closely and may, on more extensive study, be found to be a variety. It differs in characters shown in the table below, not only from *coweni* Hunter, but also from other more or less closely allied species on *Artemisia*.

Macrosiphum.

Color	filifoliæ	coweni	artemisiæ*	frigidæ	jonesii
	Brown to greenish yellow	"Dark green and moss green"†	"Deep green mealy,"	Metallic dark green shining	Black shining
Cornicle					
Length.....	2x cauda, .65 to .70 mm.	2x cauda, .55 to .70 mm.	1x cauda,	2x cauda, .40 to .64 mm.	1-½x cauda, .35 to .50 mm.
Number hairs	6 to 8	3 to 5	0	1 to 4	1 to 4
Reticulation.	Apical ⅓	Apical ⅓	Apical ½ to ⅔	Apical ¼ to ½	Apical ¼ to ½
Spur.....	.48 to .65 mm., never longer than cornicle	.60 to .90 mm., never shorter than cornicle	Longer than cornicle	.50 to .57 mm., longer than cornicle	.75 to .95 mm., 2x cornicle
Sensoria On Joint III.					
Apterous.....	3 to 8	3 to 8	10 to 14	12 to 26	8 to 10
Alate.....	11 to 22	11 to 22	22 to 30	23 to 36	18
Host	*Artemisia filifolia*	*Artemisia tridentata*	*Art. vulgaris* " *absinthii* " *abrotaniella*	*Artemisia frigida*	*Artemisia cana*

* Theobald, F. V. The Plant Lice or Aphididæ of Great Britain, I, 161. 1926.
† Wilson. Trans. of Am. Ent. Soc., 41:97, 1915.

Macrosiphum jonesii, n. sp.

Apterous Viviparous Female.—Described from three specimens taken on *Artemisia cana* at Sargent, Colorado, August 26, 1926, by C. R. Jones.

Color: Body black, shining; antennæ black, except basal half of joint III, which is dusky yellow; legs black, except proximal half of tibiæ and femora which are dusky yellow; cornicles black, cauda dusky yellow.

Measurements: Body, 2.30 mm. long by 1.25 mm. wide; hind tibiæ, 1.30 mm.; antennæ, 3 mm.; joints as follows: III, .65 to .74 mm.; IV, .47 to .52 mm.; V, .42 to .47 mm.; VI, .13 + .74 to .85 mm.; cornicles, .36 to .45 mm.; cauda, .30 mm.

Structural characters: Joint III of antennæ with 8 to 10 secondary sensoria; hairs on body moderately numerous, pointed, .05 mm. long; hairs on antennæ similar to those on body; cauda bearing 4 to 5 hairs on each side; cornicles bearing, on proximal portion, 1 to 4 hairs similar to those on body, reticulated on distal fourth to third, rather stout and cylindrical; cauda constricted near base; frontal tubercles not conspicuous; ocular tubercles present.

Alate Viviparous Female.—Described from a single specimen taken along with apterous above.

Color: Body black, shining; antennæ black, except proximal fourth of joint III; legs black, except proximal portion of femora; cornicles black; stigmas, dusky yellowish.

Measurements: Body, 2.30 mm.; hind tibiæ, 1.30 mm.; antennæ, 2.80 mm.; joints as follows: III, .59 mm.; IV, .48 mm.; V, .49 mm.; VI, .12 + .95 mm.; cornicles, .35 mm.; cauda, .30 mm.

Secondary sensoria on III, 18 in number. Other characters as in apterous described above.

This species is closely related to *Macrosiphum coweni* Hunter and *filifoliæ*, n.sp. These three may be food-plant varieties of the same species. *Macrosiphum jonesii* is distinguished from the other forms by the shorter cornicles and slightly longer antennal spurs, making the spur twice the cornicle length; *filifoliæ* has spurs usually shorter than cornicles, and *coweni* never shorter, but may be one and one-half times cornicles. *Jonesii* resembles *artemisiæ* Boyer* structurally, except the hairs on the cornicles, and the color which is green. The frontal tubercles seem less prominent in this species, being more like *Aphis artemisicola* Williams, which it really resembles except for the much larger cauda.

* According to figures and description by F. V. Theobald, 1926. Plant Lice or Aphididæ of Great Britain, Vol. I, p. 161.

Anuraphis minutissima, n. sp.

Apterous Viviparous Female.—(Plate III, Fig. 1; Plate IV, Figs. 6 and 7). Described from five examples taken on *Artemisia filifolia* at Denver, Colorado, October 8, 1918, by L. C. Bragg.

Color: Body black, covered throughout with powdery reticulations; all appendages black, except joint III of antennæ and middle of tibiæ which are dusky.

Measurements: Body, .95 to 1.25 mm.; hind tibiæ, .30 to .40 mm.; antennæ, .40 to .50 mm.; joints as follows: III, .08 to .13 mm.; IV, .06 to .08 mm.; V, .08 mm.; VI, .07 + .04 to .06 mm.; cornicles, .035 mm.; cauda, .04 mm.

Morphological characters: Secondary sensoria on antennæ absent; all antennal segments rugose; hairs on body, .05 mm. in length and moderately numerous; hairs on antennæ very small and sparse; cauda with six curved hairs, two dorsal and four lateral; cauda parallel sided, blunt at the tip; cornicles cylindrical or slightly tapering toward tip; ocular tubercles present; lateral tubercles evident on prothorax and first and seventh abdominal segments.

Alate Viviparous Female.—(Plate III, Fig. 2; Plate IV, Figs. 1, 2 and 3). Described from six examples taken on *Artemisia filifolia* at Denver, Colorado, August 13, 1919, by L. C. Bragg.

Color: Body black on thorax, dark brown on abdomen; abdomen covered throughout dorsum with white powdery reticulation; legs black except middle half of tibiæ, which is yellowish; antennæ and cornicles dusky to black; wings hyaline, stigmas dusky yellow and wing insertions greenish yellow.

Measurements: Body, 1.30 mm.; hind tibiæ, .50 mm.; antennæ, .54 to .60 mm.; joints as follows: III, .14 to .20 mm.; IV, .09 to .11 mm.; V, .09 to .10 mm.; VI, .07 to .09 + .06 mm.; cornicles and cauda as in apterous described above.

Morphological characters: Secondary sensoria present on joint III only, rather large, arranged in a single row, 2 to 5 in number; all other characters as in apterous; wing venation normal except medias which may be only once forked.

Apterous Oviparous Female.—(Plate III, Fig. 3; Plate IV, Fig. 8). Described from 14 examples taken on *Artemisia filifolia* at Denver, Colorado, October 9, 1918, by L. C. Bragg.

Color: Same as apterous viviparous form.

Measurements: Body, 1.35 mm.; other measurements and characters as in viviparous, except hind tibiæ which are much swollen along entire length and rather thickly covered on both sides with rather large sensoria.

Alate Male.—(Plate III, Fig. 4; Plate IV, Figs. 4 and 5). Described from 20 examples taken along with apterous oviparous females.

Color: Same as alate viviparous female.

Measurement: Body, .90 to 1.00 mm.; hind tibiæ, .40 mm.; antennæ, .60 mm.; joints as follows: III, .18 to .23 mm.; V, .09 to .13 mm.; VI, .07 to .10 + .05 to .10 mm. All other characters as in

alate viviparous female, except secondary sensoria on antennæ which are as follows: joint III, 11 to 16; IV, 5 to 12; V, 3 to 6.

Collections were all taken on *Artemisia filifolia* at Denver, Colorado, by L. C. Bragg.

Apterous Viviparous Female. Four collections, July 10 to October 8.

Alate Viviparous Female. Three collections, July 10 to August 14.

Sexuales. One collection, October 8.

Anuraphis filifoliæ, n. sp.

Apterous Viviparous Female.—(Plate III, Fig. 9; Plate IV, Figs. 9, 10 and 11). Described from five examples taken on *Artemisia filifolia* at Fort Collins, Colorado, August 5, 1918, by L. C. Bragg.

Color: Entire dorsum dark brown to blackish, lighter brown on dorsum of prothorax, except median and pair of dorso-lateral areas, entire dorsum of abdominal segments 1, 6, 7 and 8, and lateral portions of all segments, the lighter areas covered with white powdery reticulations; legs pale buff with tarsi and tips of tibiæ black and distal half of femora dusky; antennæ dusky to black beyond joint IV, dusky on two basal joints, otherwise pale buff; cornicles black; cauda concolorous with body.

Measurements: Body, 1.10 mm. on length by .50 mm. in width; hind tibiæ, .35 mm.; antennæ, .50 mm.; joints as follows: III, .10 to .14 mm.; IV, .08 to .09 mm.; V, .08 to .10 mm.; VI, .08 to .09 + .08 to .09 mm.; cornicles, .075 to .11 mm.; cauda, .04 mm. on median line, .075 on sides.

Structural characters: Secondary sensoria on antennæ absent; hairs on body pointed, sparse, .03 mm. long, similar on antennæ and legs; cauda with six long curved hairs; cornicles clylindrical but sometimes slightly broader at the base, surface imbricated; lateral tubercles present on prothorax and first and seventh abdominal segments; beak just surpassing third coxæ; ocular tubercles present.

Apterous Oviparous Female.—(Plate IV, Figs. 14 and 15). Described from eight examples taken on *Artemisia filifolia,* at Denver, Colorado, October 9, 1918, by L. C. Bragg.

Body dark or brownish amber, head conspicuously black, with same pattern of white reticulation as in apterous viviparous. All other characters as in viviparous except hind tibiæ which bear from 4 to 12 rather large irregular sensoria scattered along middle half, no swelling evident. Body more spindle shaped than in viviparous form and abdomen more prolonged behind the cornicles; body 1.2 to 1.5 mm.; cornicles, .04 to .06 mm.

Apterous Male.—(Plate IV, Figs. 12 and 13). Described from 12 examples taken on *Artemisia filifolia* at Denver, Colorado, October 9, 1918, by L. C. Bragg.

Color and markings similar to apterous viviparous female.

Measurements: Body, 1 mm.; hind tibiæ, .38 mm.; antennæ, .60 mm.; joints as follows: III, .13 to .18 mm.; IV, .10 to .14 mm.; V, .10 to .13 mm.; VI, .08 to .10 + .07 to .10 mm.; cornicles, .03 mm.

Structural characters: Secondary sensoria present on antennæ as follows: III, 3 to 8; IV, 3 to 9; V, 2 to 5; all other characters as in viviparous and oviparous females.

Collections were taken on *Artemisia filifolia* at Denver and Fort Collins, by L. C. Bragg.

Apterous Viviparous Female, three collections, July 10 to August 5.

Sexuales, one collection, October 8.

This species is definitely distinguished from *Anuraphis minutissima* by the reticulated pattern on the dorsum, the different character and arrangement of the sensoria on the tibiæ of the oviparous females, and the apterous males. The longer cornicles and joint III and spur of the antennæ also distinguish the species, though they merge together in some examples, and in the sexuales the cornicles do not exceed those of *minutissima* in length. It also seems to be quite similar to *Anuraphis* (Aphis) *canæ* Williams on *Artemisia cana*. It differs in color and, in the apterous, in the shorter cornicle and joint III of the antennæ, and in the relative lengths of joint III, spur and cornicles, and by the spur and cornicles being subequal and both but a little shorter than joint III. In *canæ* joint III and the cornicles are subequal and nearly twice as long as the spur.

Additional Observations on Several Described Species on Artemisia.

Anuraphis canae Will.

Aphis canæ Williams, 1910, *Aphididæ* of Nebraska, p. 39.

It seems proper here to give observations on type slides of *A. canæ* Williams, both from the National Museum in Washington, D. C., and from the collection in Nebraska, kindly loaned to us by Dr. P. W. Mason and Myron H. Swenk, respecttively.

Apterous Viviparous Female.

Measurements: Antennal joints as follows: III, .18 to .22 mm.; IV, .15 to .18 mm.; V, .13 to .15 mm.; VI, .10 + .10 to .13 mm.; cornicles, .15 to .25 mm.; cauda, .04 mm.; hind tibiæ, .55 to .60 mm.

Alate Viviparous Female.—(Plate IV, Fig. 16).

Measurements: Antennal joints as follows: III, .18 to .20 mm.; IV, .12 to .16 mm.; V, .14 to .15 mm.; VI, .10 + .13 to .16 mm.; cornicles, .11 to .15 mm.; hind tibiæ, .55 mm.; secondary sensoria on joint III, 3 to 5.

In the original description of the alate, Williams states that "joint VI equals VII." The slides show this character only in the apterous; in the alate, VI (base) being about three-fourths of the spur. Type slide No. 54 of the Nebraska collection contains one winged example of *Aphis artemisicola* Williams and this is evidently what J. J. Davis, in his "Critical Review of the *Aphididæ* of Nebraska," took to be *Aphis canæ*. The rest of the examples on the slide and those on slides 60 and 61 from the National Museum correspond quite closely with Williams' description. *A. canæ* is clearly distinct from *A. artemisicola*, not an apparent synonym as Davis states.

Collected in Colorado only once, on *Artemisia cana* at Steamboat Springs, August 8, 1926, by C. R. Jones.

Anuraphis hermistonii Wilson.

Aphis hermistonii Wilson, 1915, Trans. Am. Ent. Ssc. Vol. 41, p. 93..

Perhaps it may be of value to add some measurements of *Aphis hermistonii* as observed on the type slide and also on another slide from H. F. Wilson's collection, kindly loaned us by A. A. Granovsky.

Apterous Viviparous Female.—(From type slide No. 451).

Antennal joints measured as follows: III, .17 to .25 mm.; IV, .11 to .15 mm.; V. .11 to .15 mm.; VI, .10 mm. + .15 to .20 mm.; cornicles, .20 to .35 mm.; hind tibiæ, .40 to .50 mm.

Alate Viviparous Female.—(From type slide No. 451).

Antennal joints as follows: III, .18 to .23 mm.; IV, .12 to .14 mm.; V, .12 to .15 mm.; VI, .10 + .18 mm.; cornicles, .10 to .17 mm.; hind tibiæ, .50 to .60 mm.; secondary sensoria on III only, 4 to 5 in number.

On another slide taken May 2, 1914, at Hermiston, Oregon, on *Artemisia tridentata* containing only apterous viviparous females, the measurements were as follows: Antennal joints: III, .13 to .16 mm.; IV, .09 to .12 mm.; V, .10 to .13 mm.; VI, .10 + .08 to .12 mm.; cornicles, .12 to .20 mm.; hind tibiæ, .40 to .47 mm. It will be noted that these measurements run shorter but the longer measurements of these grade into the shorter of the type specimens. It would seem that this is a very variable species. The measurements given in the original description for apterous oviparous female are as follows: Antennal joints III, .176 mm.; IV, .154 mm.; V, .156 mm.; VI, .11 + .18 mm.; cornicles, .35 mm. For alate viviparous female: Antennal joints, III, .198 mm.; IV, .11 mm.; V, .135 mm.; VI, .01 (evidently a misprint for .10 mm.); spurs, .176 mm.; cornicles, 1.54 mm. (evidently a misprint for .154 mm.).

Apterous Oviparous Female.—Described from four mounted specimens taken on *Artemisia tridentata* at Twin Falls, Idaho, November 4, 1919, by Ralph H. Smith.

Color impossible to determine because mounted.

Measurements: Body, 1 to 1.5 mm. by .70 in width; hind tibiæ, .36 mm; antennæ, .55 mm.; joints: III, .11 to .13 mm.; IV, .06 to .09 mm.; V, .10 mm.; VI, .07 to .09 + .10 mm.; cornicles, .10 to .12 mm.

Structural characters: No secondary sensoria on antennæ; hairs on body, antennæ and legs short and sparse; cauda short and blunt, bearing six curved hairs; hind tibiæ with several rather large sensoria in middle portion, tibiæ not noticeably swollen.

Apterous Male.—Found on same slide as oviparous females described above, but so badly mutilated that only a few characters can be noted. It is apterous, smaller than the females, and bears several round sensoria on antennal joints III, IV and V.

Sexuales both very similar to those of *A. filifoliæ*, but with longer cornicles.

Comparison with *A. canæ* shows that there is very little or nothing to distinguish the two species. The color descriptions both mention green with white mottling or markings. The only differences noted were the larger size of *canæ*, 1.60 mm., body length in the apterous, and 1.35 mm., body length of apterous of *A. hermistonii*. Also the spur in *canæ* seems to show a tendency to be shorter in proportion to the rest of the joints, e.g., spur in *canæ* is never distinctly longer than IV, generally shorter, while in *hermistonii*, spur is never distinctly shorter than IV, generally longer. In both, however, they may be subequal, so no sharp line can be drawn here. However, as they occur on separate food plants, perhaps it will be best to consider them as separate species until further investigation proves then synonyms.

Collections were made as follows:

Apterous Viviparous Female, on *Artemisia filifolia*, one collection, Denver, Colorado, June 17, 1912, E. Bethel; on *Artemisia tridentata*, five collections in Estes Park and western slope of Rocky Mountains, by C. P. Gillette, C. R. Jones and L. C. Bragg, July 15 to August 8; also one collection August 30 by L. C. Bragg, near Casper, Wyoming.

Alate Viviparous Female, on *Artemisia filifolia*, one collection at Denver Colorado, June 6, by E. Bethel; on *Artemisia tridentata*, two collections, western slope of Rocky Mountains in Colorado, by C. R. Jones.

Sexuales, on *Artemisia tridentata*, one collection, Twin Falls, Idaho, November 4, by R. H. Smith.

Anuraphis oregonensis Wil.

Aphis oregonensis Wilson, 1915, Trans. Am. Ent. Soc. Vol. XLI, p. 92.

This species was included with the intention of giving a clearer idea of its general appearance, as it has not been illustrated and the original description is indefinite as to color pattern; and because the opportunity of studying the type slide kindly loaned by A. A. Granovsky, makes possible additional data as to variations in measurements.

Apterous Viviparous Female.—(Plate III, Fig. 8). Color description from several examples taken on *Artemisia tridentata*, at Cherokee Park, Colorado, August 27, 1922. Measurements from paratype slides No. 428, kindly loaned by A. A. Granovsky.

Color: Dark brown to wine red, with broad lateral portions of all segments, including the head, also a pair of dorso-medio-lateral areas on metanotum and entire first abdominal segment covered with white reticulations; legs pale yellowish, except tips of tibiæ and tarsi; antennæ yellow, except tip of joint IV, distal two-thirds of joint V and entire VI, which are black; cornicles black.

Measurements: Body, 1.40 to 1.71 mm.; antennal joints: III, .22 to .29 mm.; IV, .16 to .23 mm.; V, .15 to .20 mm.; VI, .10 to .13 + .18 to .21 mm.; cornicles, .27 to .42 mm. Measurements in original description were as follows: III, .24 mm.; IV, .22 mm.; V, .176 mm.; VI, .135 + .242 mm.; cornicles, .42 mm.; hind tibiæ, .55 to .65 mm.

Alate Viviparous Female.—Measurements from paratype slides mentioned above; antennal joints: III, .20 to .24 mm.; IV, .15 to .17 mm.; V, .15 to .16 mm.; VI, .11 to .12 + .17 to .20 mm.; cornicles, .17 to .19 mm.

Measurements, given in original description were as follows: III, .242 mm.; IV, .154 mm.; V, .154 mm.; VI, .11 + .176 mm.; cornicles, .198 mm.

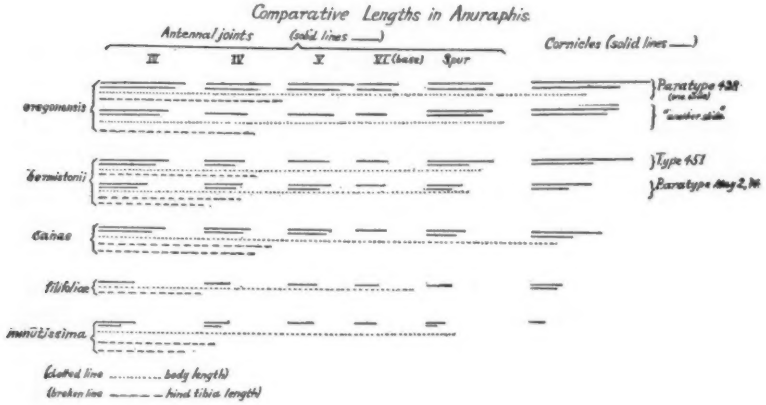
Collections were made in Colorado as follows:

Apterous Viviparous Female., on *Artemisia tridentata* at Sargent, Steamboat Springs and Cherokee Park, by C. R. Jones and the authors, three collections, July 26 to August 27; on *Artemisia gnaphalodes*, one collection at Manassa, Colorado, by C. R. Jones, August 11.

Comparison will show that this species differs very little from *hermistonii*. The only differences which can be noted are size, color and length of cornicles, and in these measurements there is great variation so that these forms grade together at the extremes. As the upper and lower limits of variation appear too extreme to include in one species, it seems best to consider them distinct and leave the line of distinction where the author of the species drew it until further study indicates otherwise.

It will be observed from the chart of comparative lengths that these species of *Anuraphis* present a gradual series of gradations beginning with *minutissima* or *filifoliæ*, and then going to *canæ*, *hermistonii* and *oregonensis*, the largest form. *A. minutissima* seems to be definitely distinguished by the characters above mentioned from *filifoliæ*. The rest of the series have the same color pattern, though *canæ* and *hermistonii* are green, while *oregonensis* and *filifoliæ* are brown. It may seem that the larger measurements are due to the larger size

of the individuals, but closer observation shows differences in proportions between base of VI, the spur, the cornicles and the hind tibiæ. In *canæ* the spur tends to be only about one-half the cornicle; in *filifoliæ*, cornicle and spur are subequal; in *hermistonii*, the spur varies from one-half of the cornicle length to being subequal with it; in *oregonensis* the spur varies from being subequal with the cornicle to being twice its length. The cornicle in *filifoliæ* is from .2 to .3 of the hind tibia in length;



in *canæ*, .3 to .4 of the tibia; in *hermistonii* and *oregonensis*, .5 to .7. In *filifoliæ*, cornicle and base of VI are subequal; in *canæ*, cornicle is 1-½ to 2 times base of VI; in *hermistonii*, 2 to 3 times, and 3 to 4 times in *oregonensis*. These differences will not hold strictly for all examples. It may indeed prove that these forms are only varieties of one extremely variable species.

Aphis artemisicola Will.

Aphis artemisicola Williams, 1910, *Aphididæ* of Nebraska, p. 37.

A few notes are added here on this species from observations on type slides, No. 56, from the United States National Museum, kindly loaned by Dr. P. W. Mason. The type slides deposited in the Nebraska collection contain only apterous specimens, so that Professor Davis had no alate types to describe or figure in his "Critical Review of *Aphididæ* of Nebraska," 1911. He does, however, describe and figure a specimen which certainly is the alate form of this species, but it occurs

by mistake on the type slide of *Aphis canæ* and is accordingly incorrectly designated *canæ* by him. Furthermore, it is not a perfect specimen, the antennæ being broken. The following measurements were taken on the alate examples on type slides No. 56 above mentioned: Joints of antennæ: III, .50 to .56 mm.; IV, .38 to .42 mm.; V, .33 to .36 mm.; VI, .14 + .57 to .68 mm.; cornicles, .34 to .37 mm.; hind tibiæ, 1.18 to 1.25 mm.; cornicles each show one or two rather weak hairs near the base; secondary sensoria on antennal joints as follows: III, 19 to 32; IV, 2 to 5; V, none.

The examples taken in Colorado west of the Continental Divide by C. R. Jones and those taken by H. F. Wilson* in Oregon differ from the types in the number of sensoria on joint III of the antennæ of the apterous viviparous females, there being 1 to 8 in number, mostly 2 to 4, while the types show 6 to 9 on type slide in Nebraska and up to 14 in one case on the types in the United States National Museum and mostly 7 to 9. The antennal joints, cornicles, and the body lengths were also somewhat shorter. It might seem that this western form should be considered a distinct species, especially as it was mostly taken on *Artemisia tridentata*, while the types are taken on *Artemisia cana*. On the other hand, about 20 examples taken in one collection on *Artemisia cana* west of the Divide seem identical with the above mentioned western form, and a slide containing four examples taken in Casper, Wyoming, on *Artemisia sp.*, contains individuals of both types. It may be best, at present, to consider them all variations of one species.

Collections of apterous viviparous females were made from *Artemisia tridentata* at Sargent, Meeker and Rio Blanco, July 26 to August 5, and *Artemisia cana* at Steamboat Springs August 8, all by C. R. Jones.

This species does not seem to fit well into any known genus. The cornicle reticulation agrees with *Macrosiphum*, the inconspicuous antennal tubercles with *Aphis*, and the acute cauda and tendency of anal plate to a median projection suggest kinship with *Bipersona* Hottes.

Chaitophorus populella, n. sp.

Fundatrix.—Described from five examples taken on *Populus* in insectary at Fort Collins, Colorado, March 30, 1914, by L. C. Bragg.

Color impossible to determine as specimens are mounted in balsam.

Measurements: Body, about 2 mm.; hind tibiæ, .50 to .60 mm.; antennæ, .72 to .90 mm.; joints as follows: III, .25 to .31 mm.; IV, .13 to .17 mm.; V, .11 mm.; VI, .08 + .17 to .20 mm.

Apterous Viviparous Female.—(Plate I, Fig. 11; Plate II, Figs, 16, 17, 18 and 22). Described from three examples taken April 20, 1914; one taken June 1, 1910, and one July 20, 1908, on *Populus* sp. at Fort Collins, by L. C. Bragg.

* Trans. Am. Ent. Soc. XLI, p. 95, 1915.

Color: Light green to yellowish, mottled with darker green as follows: a blotch on median part of mesothorax and metathorax, and a transverse stripe across dorsum of first abdominal segment; from this stripe arise two semicircular stripes running posteriorly and meeting fourth or fifth abdominal segment, from which point they diverge, ending on lateral margins of seventh abdominal segment; on third abdominal segment transverse stripes join sides of circle to lateral margin of abdomen, sometimes this latter stripe coalescing with lateral portions of stripe on first segment. Legs pale, except tarsi, which are black; antennæ pale to fifth joint, remainder blackish; cornicles very light green or whitish.

Measurements: Body, about 2 mm. long; hind tibiæ, .60 to .70 mm.; antennæ, 1.0 to 1.30 mm.; joints as follows: III, .35 mm.; IV, .17 to .20 mm.; V, .15 mm.; VI, .10 + .21 to .30 mm.; cornicles, .07 to .09 mm.

Morphological characters: Hairs on body stout and pointed, .08 to .10 mm. long, fairly numerous; on antennæ finer, about .04 mm. long; on legs about .06 mm.; cornicles truncate; cauda knobbed with distinct neck; anal plate slightly indented; ocular tubercles present.

Young born of above form (Plate I. Fig. 10), are pale green with faint traces of mottling of adult; small dark spots at bases of hairs on dorsum hardly dicernible; only tips of antennæ and tarsi blackish.

Alate Viviparous Female.—(Plate I, Fig. 12; Plate II, Fig. 19). Described from 2 examples taken on *Populus* sp. at Fort Collins, April 20, 1914, and five others taken July 14, 1908, on same host and in same locality.

Color: Head and thorax black; abdomen marked about as in apterous, green markings often coalescing so that pale yellowish color shows only as a circle on median portions of abdominal segments 2, 3 and 4 and around bases of cornicles on segments 5 and 6; faint transverse dusky bands on dorsum of abdomen; antennæ, legs and cornicles as in apterous form; wings hyaline, stigma dusky.

Measurements: Body, 1.5 to 2 mm. long; hind tibiæ, .60 to .70 mm.; antennæ, .95 to 1.40 mm.; joints as follows: III, .30 to .44 mm.; IV, .15 to .28 mm.; V, .14 to .19 mm.; VI, .09 to .11 + .20 to .30 mm.; cornicles, .05 mm.

Morphological characters: Secondary sensoria on joint III, 2 to 5; none on joints IV or V; fore wings with medias twice forked, hind wings with two cross veins.

Apterous Male.—(Plate II, Fig. 20). Described from 10 examples taken on *Populus* sp. at Fort Collins, October 21, 1910.

Color impossible to determine as specimens are mounted in balsam.

Measurements: Body, about 1.20 mm.; hind tibiæ, .50 to .60 mm.; antennæ, 1.10 to 1.40 mm.; joints as follows: III, .36 mm.; IV, .22 mm.; V, .15 mm.; VI, .08 + .21 to .24 mm.

Morphological characters: Secondary sensoria as follows: III, 14 to 20; IV, 12 to 14; V, 6; other characters as in apterous viviparous.

Alate Male.—Described from 2 examples taken with apterous males described above, and several examples taken October 10, 1909.

Color: Head and thorax black; abdomen dark green with blackish transverse dashes and lateral areas on each segment, otherwise as in alate viviparous.

Measurements: Body, 1.80 mm.; other measurements as in apterous male.

Morphological characters: Secondary sensoria as follows: III, 26; IV, 18; V, 12.* Other characters as in alate viviparous female.

Oviparous Female.—(Plate II, Fig. 21). Described from 2 examples taken October 10, 1910, with alate males described above, and 2 other examples taken October 21, 1910, with alate and apterous males descibed above.

Color not described, specimens mounted in balsam.

Measurements: Body, 1.80 to 2.10 mm.; hind tibiæ, .50 to .65 mm.; antennæ, .90 to 1.00 mm.; joints: III, .24 to .30 mm.; IV, .14 to .18 mm.; V, .13 to .16 mm.; VI, .09 + .21 to .29 mm.; cornicles and cauda as in apterous viviparous female.

Morphological characters: Same as in apterous viviparous female except hind tibiæ which are swollen and bear rather numerous roundish sensoria along almost entire length.

Collections were taken on *Populus balsamifera, angustifolia* and *Populus* sp., by L. C. Bragg and the authors, all in vicinity of Fort Collins, except one at Delta, Colorado.

Fundatrix, seven collections, March 30 to May 10.

Apterous Viviparous Female, twenty-seven collections, April 20 to Nov. 8.

Alate Viviparous Female, sixteen collections, April 20 to Sept. 26.

Apterous Oviparous Female, four collections, October 10 to October 23.

Apterous Male, seven collections, October 8 to October 23.

Alate Male, seven collections, October 8 to October 23.

This species seems to resemble very closely *Eichochaitophorus populifolii* Essig, but differs in the following points: Antennal joint III is longer than the spur, usually considerably so; V is 1-½ to 2 times base of VI; spur is 2 to 3 times base of VI, and color marking is never reddish, while in Essig's species joint III is shorter than spur,† V is shorter or subequal with base of VI, spur is 3 to 4 times base of VI and color marking in some, especially younger individuals, is red or reddish. Accordingly it seems best to consider the Colorado form distinct unless further investigation proves otherwise. It also might be confused with *Chaitophorus populifoliæ* (Oestlund) Davis.‡ (Plate II, Fig. 23), but it is very readily distinguished by the following characters: General color pale with green markings, without dark bands on abdomen of alate, and with sensoria on antennal joint III of alate never more than 7, usually 3 to 5 in a single row. In Oestlund's species, color markings are

*Some other examples observed had as few as six secondary sensoria on joint V.

† So stated in description, Pom. Coll. Jour. Ent., IV, p. 722, 1912, but two cotype examples show III and spur subequal.

‡ Jour. Ec. Ent. III, p. 489.

conspicuously dark with distinct dark bands on abdomen of alate, and sensoria on antennal joint III of alate number from 9 to 14, not in a single row.

For *Eichochaitophorus populifolii* Essig, we propose the new name *essigi*, since *populifolii* is preoccupied by Oestlund and Davis in 1910. Oestlund's species is certainly the same genus, and Baker has declared *Eichochaitophorus* a synonym of *Chaitophorus*.

Myzus alpinus, n. sp.

Apterous Viviparous Female.—(Plate IV, Figs. 29, 30 and 31). Described from numerous examples taken on *Pedicularis bracteosa*, in Pingree Park, Colorado, August 21, 1926.

General color light green without dark body markings; tips of joints III to V of the antennæ, all of joint VI and spur, all tarsi and distal ends of tibiæ black or blackish; cauda concolorous with the abdomen, cornicles in some examples slightly dusky; antennæ reaching tip of the cauda and set on very short tubercles; cornicles cylindrical and twice the length of the tarsi; cauda rather short and of the typical *Aphis* type, constricted near the base; length of body to tip of cauda 2.20 mm.; cauda, .28 mm.; cornicles, .225 mm.; joints of antennæ: III, .50 mm.; IV, .32 mm.; V, .28 mm.; VI, .15 mm.; spur, .68 mm. Secondary sensoria on joint III about 9 to 13.

Alate Viviparous Female.—(Plate IV, Fig. 28). Described from numerous examples taken with apterous described above.

The alate form differs from the apterous by having the head, thorax, antennæ, cauda, cornicles, tarsi, distal ends of tibiæ, and femora, and markings on dorsum of the abdomen black or blackish. The black markings on the abdomen consist of a median longitudinal row of transverse black dashes, lateral rows of large black spots, and one or two sub-lateral rows of small black spots. The wings are clear with slender but black veins and dusky stigmas; venation regular. Length of body 2.25 mm.; antennæ attaining tip of cauda; sensoria on joint III, about 30 to 46 and on joint IV about 12; joint V, 0 to 6.

Macrosiphum valerianæ Clarke.*

Nectarophora valerianae Clarke, Can. Ent. 1903. p. 253.

Apterous Viviparous Female.—(Plate III,Fig. 7: Plate IV, Figs. 25, 26 and 27). Described from five examples taken on *Valeriana ceratophylla* in Pingree Park, Colo., August 21, 1926, and four taken in same locality and on same host August 24, 1923.

General color a dark rusty brown, changing to light red in alcohol; cornicles, all of legs except basal portions of femora, black; cauda

*This may be a new species but our examples fit, very well, the rather meager description of this species by Clarke.

concolorous with body; antennæ reaching somewhat beyond tip of the long cauda with average length of segments about as follows: III, 1.10 mm.; IV, .75 mm.; V, .68 mm.; VI, .18 mm.; spur, 1.00 mm.; frontal tubercles large and diverging; joint III with four to nine small circular sensoria in a single row on basal half of the segment; cornicles, .90 mm. to 1.20 mm.; reticulated near the tips, quite slender and tapering in the basal portion; cauda about .50 mm., rather slender and pointed and rarely with any constriction at the middle portion and having about four to five rather stout hairs on either lateral margin; body hairs blunt and somewhat enlarged at their tips. Length of body to tip of cornicles 3.50 to 4 mm.; tibiæ, 2.60 mm.

Alate Viviparous Female.—(Plate IV, Figs. 23 and 24). Described from a single example taken on *Valeriana ceratophylla* in Pingree Park, Colorado, August 24, 1923.

The alate form differs from the apterous by having 12 to 16 sensoria on joint III of the antennæ in a single somewhat irregular row. Total length of body averaging about .5 mm. less than in the apterous form; wings clear, veins very delicate, stigmas dusky.

Collections taken on *Valeriana ceratophylla* in Colorado, altitudes 8000 to 9500 feet, at Log Cabin, Pingree Park and Grand Mesa, by L. C. Bragg, C. R. Jones and the authors as follows:

Apterous Viviparous Female, four collections, July 26 to August 24.
Alate Viviparous Female, two collections, August 4 and 24. Taken on *Epilobium* sp., by L. C. Bragg.
Apterous Viviparous Female, one collection, August 17.
Alate Viviparous Female, one collection, November 16.

M. centranthi Theobald, which also occurs on *Valeriana* species, differs from the above by having 3 to 5 sensoria on the third joint in the apterous, and 20 to 28 in the alate viviparous forms; the cornicles and third joints of the antennæ are subequal; the cauda is only one-half the cornicles in length, and the general color is green instead of brown.

EXPLANATION OF PLATES.

PLATE I.

Macrosiphum longipes, n. sp. 1, alate viviparous female; 2, apterous viviparous female.
Macrosiphum glabrum, n. sp. 3, apterous viviparous female; 4, alate viviparous female.
Macrosiphoniella frigidicola, n. sp. 5, apterous viviparous female; 6, alate viviparous female; 7, apterous male; 8, apterous oviparous female; 9, egg.
Chaitophorus populella, n. sp. 10, young viviparous female; 11, apterous viviparous female; 12, alate viviparous female.

PLATE II.

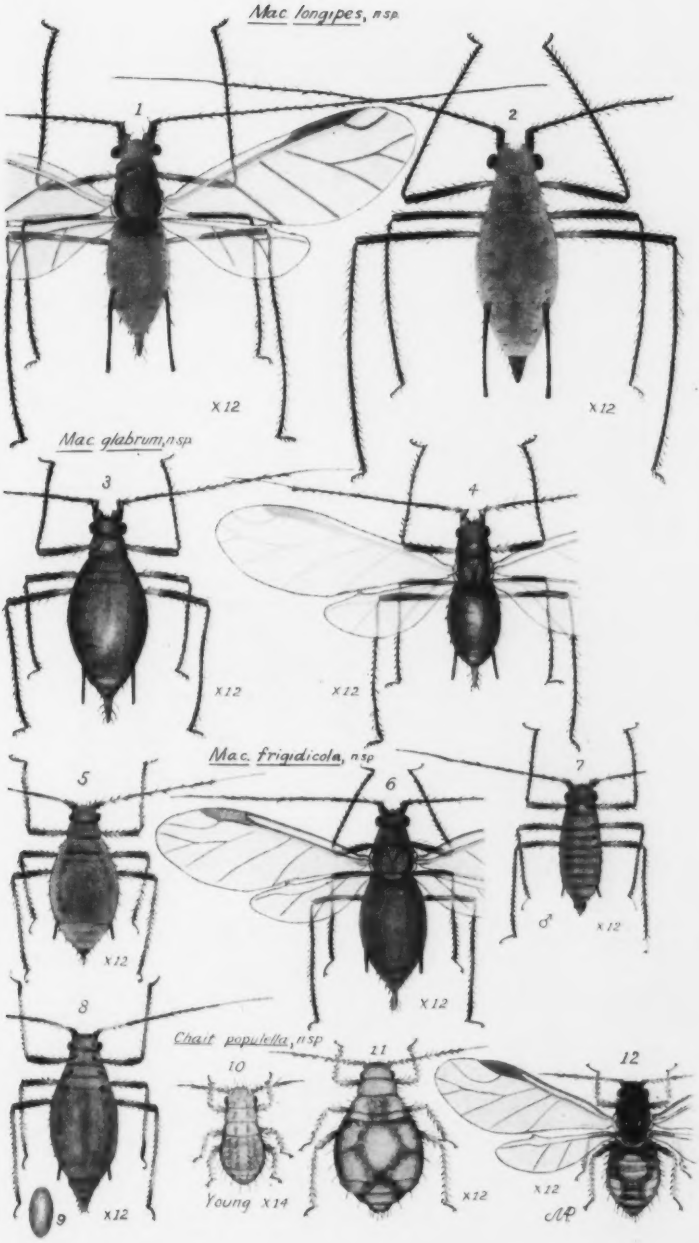
Macrosiphum longipes, n. sp. 1, antenna of apterous viviparous female; 2, cornicle of same; 3, antenna of alate viviparous female; 4, cauda of same.
Macrosiphum glabrum, n. sp. 5, antenna of apterous viviparous female; 6, cornicle of same; 7, antenna of alate viviparous female; 8, cauda of same; 9, cauda of apterous viviparous female.
Macrosiphoniella frigidicola, n. sp. 10, cauda of apterous or alate; 11, antenna of apterous viviparous female; 12, cornicle of same; 13, antenna of alate viviparous female; 14, antenna of male; 15, hind tibia of oviparous female.
Chaitophorus populella, n. sp. 16, antenna of apterous viviparous female; 17, cauda; 18, cornicle of same; 19, antenna of alate viviparous female; 20, antenna of apterous male; 21, hind tibia of oviparous female; 22, anal plate of apterous viviparous female.
Chaitophorus populifoliæ (Oest.) Davis. 23, antenna of alate viviparous female.

PLATE III.

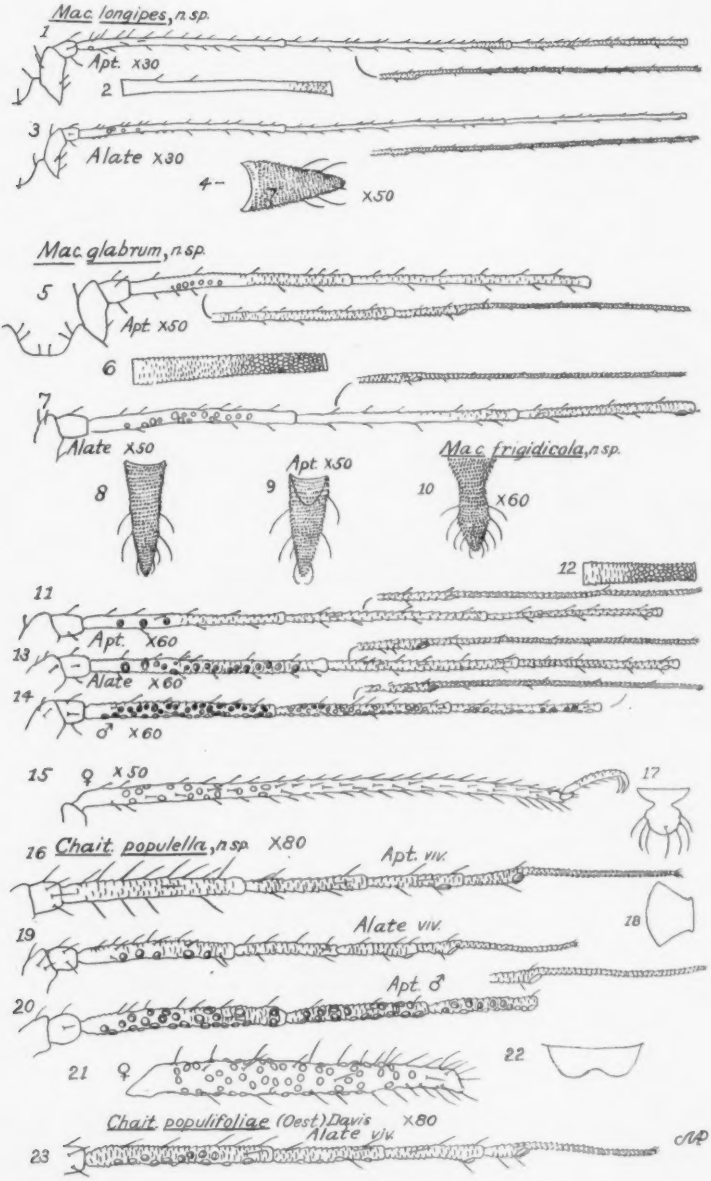
Aphis minutissima, n. sp. 1, apterous viviparous female; 2, alate viviparous female; 3, apterous oviparous female; 4, alate male.
Macrosiphum filifoliæ, n. sp. 5, apterous viviparous female; 6, alate viviparous female.
Macrosiphum valerianæ Clarke. 7, apterous viviparous female.
Anuraphis oregonensis Wil. 8, apterous viviparous female.
Anuraphis filifoliæ, n. sp. 9, apterous viviparous female.

PLATE IV.

Anuraphis minutissima, n. sp. 1, antenna of alate viviparous female; 2, cornicle of same; 3, cauda of same; 4, antenna of male; 5, cornicle of same; 6, antenna of apterous viviparous female; 7, cornicle; 8, hind tibia of same.
Anuraphis filifoliæ, n. sp. 9, apterous viviparous female; 10, cornicle; 11, cauda of same; 12, antenna of apterous male; 13, cornicle of same; 14, hind tibia of oviparous female; 15, cornicle of same.
Anuraphis canæ Will. Antenna of alate viviparous female.
Macrosiphum filifoliæ, n. sp. 17, antenna of apterous viviparous female; 18, antenna of alate viviparous female; 19, cauda; 20 cornicle of same.
Macrosiphum frigidæ Oest. 21, antenna of apterous viviparous female; 22, antenna of alate viviparous female.
Macrosiphum valerianæ Clarke. 23, antenna of alate viviparous female; 24, vertex of same; 25, antenna of apterous viviparous female; 26, cauda; 27, cornicle of same.
Myzus alpinus, n. sp. 28, antenna of alate viviparous female; 29, vertex and third antennal joint of apterous viviparous female; 30, cauda; 31, cornicle of same.



Gillette and Palmer



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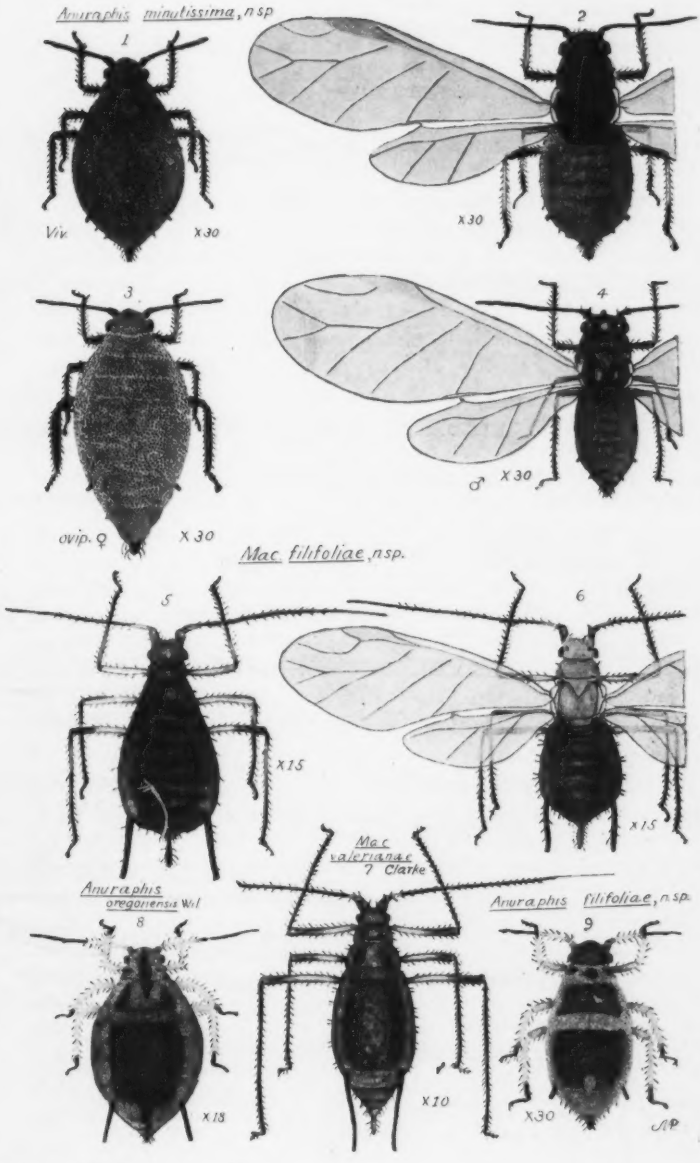

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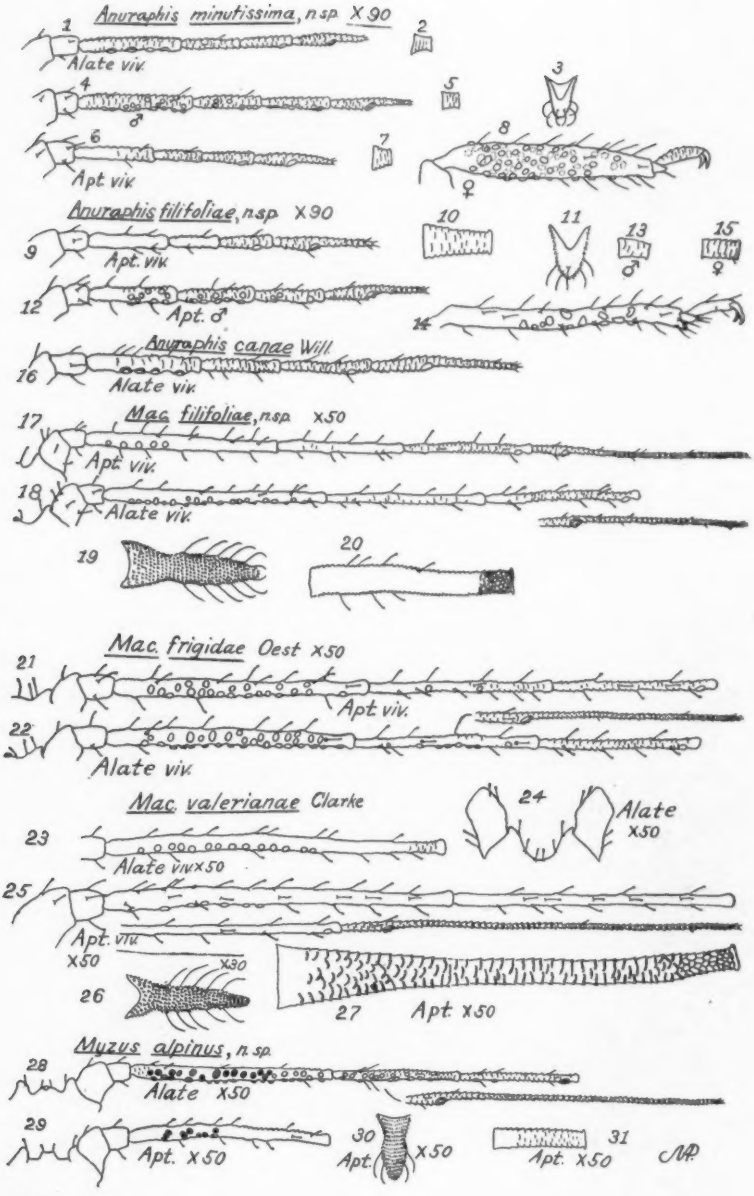

Gillette and Palmer

THE NESTING HABITS OF THE WASP, CHALYBION CAERULEUM.

PHIL RAU,
Kirkwood, Mo.

It sometimes happens that a pioneer investigator, in the course of his studies, makes an error, and others, following the method laid down by him, only make the crooked path well-trodden until the error is commonly accepted as truth and eventually stands unquestioned. Thus the life-history of the spider-huntress, *Chalybion caeruleum*, has been accepted as described by the first observers and repeated by many others, including myself. This universally accepted belief is that *C. caeruleum*, the steel-blue wasp, is a mud-dauber and builds its own nest. It is quite natural that investigators, seeing these wasps emerge from mud nests, concluded that the wasps built the nests, especially since they are often to be seen working on the nests or loitering at the water's edge. No one, so far as I can learn, has ever carefully followed the work of the mother *Chalybion;* else this error would certainly have been detected, or at least not so persistently perpetuated. The following notes will show that this steel-blue wasp is a water-carrier, and not a mud-carrier, and that with the water which she brings in her gullet she softens the mud and alters the nests of *Sceliphron caementarium* which she appropriates for her own use.

My doubts were first aroused by the fact that these wasps, when they arrived at the mud-puddles, would alight not on the mud but at the water's edge, and, with all six legs planted on the ground, they would take long draughts of the water and fly away; they never took mud, whereas, at the same puddles the yellow-legged mud-daubers, *Sceliphron caementarium*, would stand on their heads and bite out round pellets of mud and carry them away. Then again their manner of sleeping, their habit of congregating in hundreds each night at a common shelter, in a manner somewhat similar to that of the parasite, *Elis 5-cincta*, led me to believe that they might be parasitic without an established home of their own. But only an accident, which I am about to relate, led to the discovery and

gave proof that *C. caeruleum*, while not wholly parasitic, at least uses the mud nest and often destroys the young of *S. caementarium*.

In the fall of 1918 I gathered, in an open shed on the hill-top at Wickes, fifteen mud-dauber's nests and laid them in a pile on a shelf with the intention of coming back and getting them later. Other interests led me home by a different route, and the nests were forgotten until a year later, September 16, 1919, when a search was being made for *Polistes* nests in this building and the pile was found just where I had left it. A cursory examination of the lot was made, and it was noted that the cells were open, and the wasps had emerged. The old pupal cases were to a great extent disintegrated, and the presence of *Dermestes* larvæ indicated that the work had been done by them. However, two of the cells had been used during the year by *Pseudagenia mellipes*, and in addition about a dozen cells had clearly been resealed in a manner new to me. The mud had been piled on the opening in small chunks, but not packed in and spread smooth to form a neat plug, as is the custom of *Sceliphron*. Moreover the chunks were placed one atop the other in a haphazard arrangement that extended perpendicularly in a column or rough mound a quarter of an inch above the surface of the nest. Many of the nests bore marks of the mandibles, showing that the user of these old cells probably got the sealing material from the walls of the same nest (see fig. 1). Now I knew that certain bees, as *Osmia lignaria*, reseal old *Sceliphron* nests, as do likewise some wasps, *Pseudagenia mellipes*, *Trypoxylon clavatum*, *et al.*, but clearly this was a new way of resealing them.

Upon opening the cells, I found that about ninety per cent. of them had belonged to *S. caementarium*, the yellow-legged mud-dauber, and the remainder had been occupied by *Chalybion caeruleum*, the blue wasp. The criterion for this distincion was the pupal case which remained in each cell. It will be remembered that the yellow-legged wasp makes a brown, papery cocoon, and the blue wasp makes one of the same kind but in addition spins a white, webby covering completely over it. These statements apply to the old open cells from which the fledgelings had gone; in the cells that were so peculiarly resealed we found healthy, immature wasps of the species *C. caeruluem*. Obviously, one or more mother wasps of this

species had come by chance upon this pile of nests and used the cells for nidus. I had arrived upon the scene too late to learn with certainty just how it happened that *Chalybion* young were present in about ten per cent. of the previous year's nests as they lay in a heap on the shelf, but since each and every one of these resealed cells belonged to *Chalybion*, it was here apparent that this wasp is a renter and not a builder of houses. Moreover, it was evident that she had learned to bite the mud wherewith to seal the cells from the walls of the nest itself. This process, then, would entirely eliminate the mud-carrying function of this species.

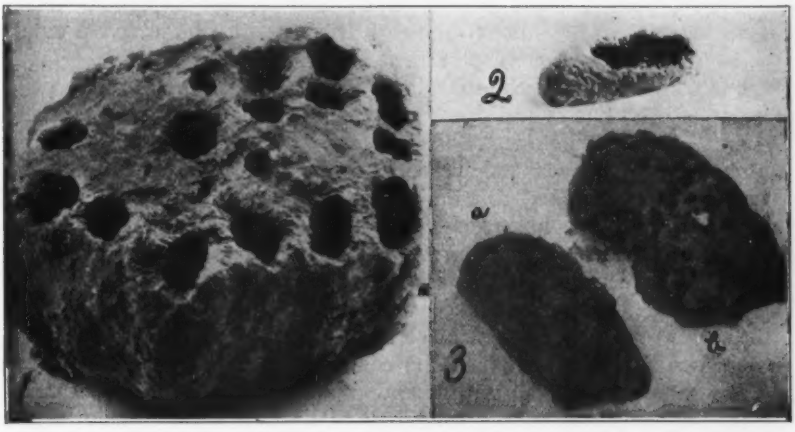

Fig. 1. The mandible marks made about the openings of cells of a Sceliphron nest by the cow bird wasp *Chalybion caeruleum*. (Natural size).
Fig. 2. The damage done to a Sceliphron nest of *Chalybion caeruleum*. (Natural size).
Fig. 3. Nests of *Chalybion caeruleum* decorated with (a) pollen grains, (b) chewed up spider web.

With these suspicions in mind, I paid careful attention to these wasps when I found them on mud nests during the following summer, and the resultant observations all tended to prove the correctness of the hypothesis suggested above. Since the records are so new and may some day be of use for comparative data, it may be well here to preserve the details.

June 28, 11:30 A. M., Wickes, Mo. The blue wasps were found busying themselves about some mud nests in a little out-

building near the club-house in the valley. The heat and atmosphere were stifling, but to solve the problems of the economy of this species was worth the price. To the right was the completed nest of a *S. caementarium*. At short intervals was to be heard the shrill buzz of the industrious mother as she vigorously pressed down each load of mud that she brought in to reinforce the outside walls of her nest. And well might she strengthen the walls, for her neighbors, two *C. caeruleum*, were conducting themselves in a suspicious manner on other nests not more than two feet distant.

On one of these *Sceliphron* nests upon which the *Chalybion* were loitering, there was a round hole in one side near the sealed entrance, about one-eighth inch in diameter. Very soon the steel-blue wasp returned from an excursion, and spat out some water on the margin of the hole, thus making a little dot of mud out of the dry clay, which she bit off in a little ball and dropped below. This process she repeated until her supply of water was exhausted; then she flew away and brought more and continued to enlarge the aperture through the heavy wall. After she has used up four or five loads of water, the opening was large enough to admit her head. Then presto! she reached in, grabbed a spider and dropped it to the ground, then another and another until seven had been discarded. Some were carried a foot or so away from the nest before being thrown down. Now that the cell had thus been cleaned out, she spent some time within and much time on the outside of it, lingering and doing nothing, or apparently not knowing what to do. Throughout the remainder of the afternoon she kept going out on extended excursions, about forty minutes at a time, as if foraging, but each time came back empty handed. When on the nest she did nothing. At 6:30 she went to roost for the night with the flock.

June 29. She returned at 9:20 A. M. from her prolonged night's absence, and alighted on the nest, went inside the cell and in a quick survey seemed familiar with the place; then she flew away as if on business bent. Up to 10 o'clock she did not return, and I was then obliged to leave. The cell was still empty, with clean smooth walls.

Another cell in the same nest gave evidence of having been resealed by *Chalybion*, and an examination of the contents led me to believe that it had been also refilled by her. This cell

contained 21 spiders; seven of these had shriveled abdomens; the others were plump; none could move, and only two could show the faintest signs of life.

The *Chalybion* on the other nest had meanwhile been carrying on a somewhat different type of behavior. When my attention first fell upon her, she was bringing water, wetting a certain spot on the outside wall of the nest, biting out chunks of mud and carrying them to another cell in the same nest for the purpose of sealing it. This plug was rough and already thicker than those customarily made by *Sceliphron*, yet for some time she continued going for water and adding to her plug. At length the depression which she had been making by these excavations had become quite deep and round; with the removal of one more ball of mud the bottom of the depression broke through into the cell beneath, and lo, her entrance was already cut into another cell! What wonderful economy! Certainly she was killing two birds with one stone; she was getting mud near at hand to seal one cell, and by so doing she was opening her second cell. Furthermore, her ingenuity seemed above reproach, for even while I was wondering what she would do next, she went to a protuberence at the opposite end of the nest for just a little more mud with which to complete the plug to her satisfaction. Is it possible that she realized that if she increased this opening unnecessarily, she would have to replace just that much more when the time should come to close it? The new cell proved, when explored with a probe, to be completely empty; evidently the builder of this cell had sealed it up empty, as *S. caementarium* sometimes do.

Now that she had access to the new cell, she was at once busying herself going in and out, occasionally bringing out chunks of dry clay and throwing them away, but more often bringing in nothing; evidently she was dressing down the interior walls to suit her taste. Presently she went for water, moistened the outside of the nest to make mud and gathered mouthful after mouthful of it and carried it inside to plaster the walls smoothly. One gulletful of water made about four of these loads of mud. On her way back to the nest she loitered in a manner as if foraging among the blackberry blossoms outside the door, sometimes for many minutes at a time, but eventually came in and resumed her work just where she had left it, smoothing out each layer of plaster on the inside wall and

finishing with a shrill buzz. At intervals all the afternoon she carried mud from one spot on an adjacent cell to line the one on which she was working. By five o'clock she had in like manner neatly opened the next cell. When it seemed, an hour later, that she had gone to sleep for the night, I stealthily examined the cell on which she had been working and found some spiders stored therein. She returned, however, and caught me in the intrusion just as I was replacing her spiders. Seeing the disturbance, she promptly swooped down on the cell and forthwith emptied it of its spiders, excepting two. Some she threw out of the cell door, others she carried away a short distance on the wing and discarded. There were nine in all, and had probably been brought in stealthily or swiftly when my attention was directed to the work of the other *Chalybion*. Had she faithfully hunted each one among the bushes, or had she robbed some other cell? Her hot-tempered attitude in discarding all her booty simply because it had been disturbed by some one was quite in keeping with other instances of a similar nature which we have recorded elsewhere for *Sceliphron*.*

She did not reappear next morning until eight o'clock, and then she came in with an industrious buzz and a spider in her jaws. One is inclined to say: "When she works honestly, she buzzes; when she steals, she does it quietly." She carried her medium-sized spider under her chin, holding it up with her forelegs and mandibles. When she paused and rested thus on the ledge in front of the open cell, I pressed nearer to see why she did not enter. Then I found that her sting was inserted in the abdomen of the spider, and there it remained for perhaps a quarter of a minute. I can not say whether this was the first sting which the wasp had administered to its victim. The abdomen was of course curled under until the sting was near her mouth; when she withdrew the sting, she slowly straightened the abdomen and then carried the spider inside. She soon departed and returned in a few minutes with a little yellow spider which she placed in the cell without stinging it while she was on the nest. For some time thereafter, she was bringing in spiders at the rate of one in every four to fifteen minutes, and placing them in the cell either with or without the final stinging just before they were placed inside. At about ten

*Field Studies in the Behavior of Non-Social Wasps. Trans, acad. of Science, St. Louis. 1928.

o'clock she paused in her labors and simply lingered about the nest for a few minutes, rather as if meditating or considering something, and then proceeded to plug up the opening.

The next morning at 8:30, I paid my last visit to the nest, now sealed, and examined the interior of the cells. The first cell which she had sealed contained 38 spiders, tightly packed; these varied in size from very small to medium, and in color from light yellow to almost black. They were all soft and plump; only a few showed feeble signs of life. The second cell, the one which had been sealed in my presence, and the one from which the mother, in the heat of her indignation, had thrown out so many good spiders, now contained only four small spiders, surely an entirely inadequate store of provisions to carry the larva through to maturity. These four rattled around so freely in the cell that one could not tell whether the egg had been placed on the first or the last spider.

Another *C. caeruleum* was observed provisioning her cell. After she was discovered she brought in six spiders in a period of one hour and twenty minutes; a little later she began to seal the cell. Since the original nest was composed of only a single cell, there was no place immediately at hand where she could borrow the necessary supply of mud for sealing the aperture. Only a few inches below this nest, however, was a lump of mud adhering to the wall where in the previous season I had knocked down a mud nest. This she carefully harvested and scraped from the wall and carried up to her nest. When this cell was opened later, it was found to contain seventeen spiders, mostly very small, of many species. Each spider was examined carefully, but no egg was discovered. The spiders all seemed dead; even with a magnifying glass, no signs of life could be detected, despite the fact that they had all been stored only about thirty-six hours previously.

After these exciting experiences, I carefully observed every blue wasp that I could find in various localities, to learn how general is this habit of borrowing nests instead of building them. Dozens of these wasps, in all, were seen on nests, and in each and every case the nest was one which had been used previously. I often watched them go to the water; they would invariably fly direct to the water's edge, stand on all six feet, drink their fill and fly heavily away. Certain marked individuals came again and again to precisely the same spot for their supply of

water. They were not at any time seen "standing on their heads" and gathering mud, as do *Sceliphron caementarium*.

In utilizing the building materials convenient at hand, they frequently arrive at strange results. Fig. 2 shows a one-celled nest of Sceliphron that had been demolished for its materials. One nest had imbedded in the portion of its wall which formed its closure portions of black spider webs which had been scraped from the walls of the shed and chewed into small, compact balls (Fig. 3 b). Another nest was extremely conspicuous because the material for the plug, which had likewise been gathered from a wall nearby, contained much kalsomine, and extended beyond the nest for at least a quarter of an inch. Another had little yellow pellets of sawdust or pollen grains imbedded all over the surface, (Fig. 3 a), while another likewise bore several empty eggshells of some moth.

Since among the many nature students who have written about these wasps in either a technical or a popular way, not one has elsewhere recorded these details, *i.e.*, the habit of breaking into the nests of *S. caementarium*, and of carrying water, the way of picking up whatever material is near at hand wherewith to plug the aperture, or of removing parts of the same or some other mud nest to finish a cell, I really wonder if this group of habits is general, or if it is possible that these habits may be newly acquired, or even a local condition. The *Chalybion* are plentiful about Wickes; as recorded elsewhere, they have been seen congregating regularly at their sleeping quarters in hundreds or even thousands. On the other hand, the *Sceliphron* seem to be less numerous; probably not more than a few dozen live nests could be found at any one time in the immediate vicinity. The question at once arises: what will become of *Chalybion* if the population of *Sceliphron* becomes reduced or exterminated? The chief advantage of the little burglar lies in the fact that the mud nests of *Sceliphron* last year after year, and the aggregate product of a few mud-daubers for a few years affords adequate provision for a large number of *Chalybion*. One wonders what would happen if *Sceliphron* nests should disappear. Would *Chalybion* make her own mud nests, or would she descend to the use of a hole in a bank or in wood, like *Trypoxylon* or *Monobia?* These habits, whether they be old or new, are of decided advantage to the species. Since a great portion of the life of a wasp must

normally be spent in nest-making, if *Chalybion* can save that time and devote it to spider-hunting, she can in the same time provision a great many more nests than a wasp which builds her own cells. Furthermore, the specialization in her work would soon tend to make her more proficient in her hunting and further augment her accomplishment. This is precisely the condition which I have actually found in the cases accurately observed; in those instances, *Chalybion* was actually bringing in two or more spiders to *Sceliphron's* one.

To return to the question of whether *Chalybion* has acquired these habits in recent years, and is rapidly changing simultaneously in various regions from an industrious creature to a physically economic one, or whether these habits are of long standing; in comparing the habits of *C. caeruleum* with those of other wasps of this genus, I find that Williams, giving Maindron (1878)* as authority, says that *C. laetus* in the Moluccas, in building a cell, leaves both ends open until the last so that she may more readily enter and leave it, and that the wasp passes the night in one of the cells. Williams also gives some highly interesting facts in the nest-building of *C. violaceum* Fabr.: "This brilliant household insect can hardly be said to construct cells. . . . . She is a poor architect and stores her small spiders in some convenient hollow, as a rung socket, pen-holder base, old mud nest, etc., and simply plugs up the aperture, first with mud or moist earth, and finishes this off with a mixture formed of the excreta of geckos (lizards), giving the plug a whitish or plaster-like appearance." D'Herculais (1882) has also noticed this curious habit in the case of *C. chalybeus* at Port Natal, Africa, the material there used being bird excrement. Thus we see in the Philippine *C. violaceum* habits in using the old mud cells the same as we have found in the American *C. caeruleum*, only the Philippine wasp goes our species one better in using any ready-made object affording a burrow of approximately the proper size. So it seems to me that my Missouri *Chalybion* are not guilty of a lapse from conventionality in their own world, but have come by their questionable habits honorably, if following precedent establishes honor. I suspect further that the same habit of *C. caeruleum* in borrowing rather than building nests would be recorded for

* Williams, F. X. Philippine Wasp Studies. Bull. Hawaiian Exp. Sta. 14:118-119. 1919.

all other localities, had the investigators studied the mothers at work, instead of taking the nests and recording the emerging species as author of the whole. Throughout all the literature on this species, each investigator takes it for granted that *C. caeruleum* is a mud-dauber, just as naturalists still think that *Monobia quadridens* is a carpenter mud wasp.

It might be possible that *C. caeruleum* is to *S. caementarium* what *Psithyrus* is to Bombus, or what *Stizus unicinctus* is to *Chlorion thomæ*,* or what *Pseudomelecta interrupta* is to *anthophora*** or what many other cow-bird Hymenoptera are to various hosts from which they have descended, as Wheeler shows in his excellent treatise, The Parasitic Aculeata.† I should not be at all surprised if it should be proven that a close kinship exists taxonomically, and that the blue wasp is today in a transition stage to a state of parasitism, similar to that which exists in the many species of Hymenoptera that Wheeler discusses. In fact, until recently both species were placed in the same genus, *Pelopoeus*, and even quite recently Hutson‡ placed this blue wasp in the genus *Sceliphron*, where it is placed on taxonomic equality with its host.

One has only to see the struggles of *S. caementarium* gathering mud during an unusually dry spell to be able, with a little imagination, hypothetically to trace the steps by which a mud-carrying wasp may become a water-carrier. It is easily possible that as the mud stiffens to hard clay with the drying up of the puddle, saliva is thrown out as a pellet is energetically bitten up; this makes the tough earth less resistant; losing saliva in this way creates a thirst, which can be quenched by clear water or dew. With sufficient replenishment the wasp is able to go to hard clay and bite out wet chunks, just as we see various species of the Eumenid wasps do. With abundant moisture in the mouth, they may go anywhere for clay, or it is even possible for them to remain on the nest and obtain mud nearby from the same or another nest. Thus the habit of mud-carrying can, it seems to me, give way to water-carrying, with a corresponding method of nesting.

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* Rau and Rau. Wasp Studies Afield, 1918.

** Rau. The Ecology of a Sheltered Clay Bank. Trans. Acad. Science, St. Louis, 25:158-260, 1926.

† Proc. Amer. Philos. Soc. 58:1-40. 1919.

‡ Trans. Amer. Ent. Soc. 45:203. 1919.

There is another problem in connection with the prey of *C. caeruluem.* Since she uses the same spiders as does her host, why does she completely get rid of them before she brings in her own? In "Field Studies in the Behavior of Non-Social Wasps"* I show that *S. caementarium* lays her egg on the first spider brought in—that is, its position in the cell is furthest back—and it is necessary for *Chalybion* to throw out all of the prey in order to reach this one, and when she lays her own egg, it is on the last one brought in. It seems utter extravagance to waste such good food; perhaps some day *C. caeruleum* will learn to destroy the egg without discarding the prey, as we now know that *Stizus unicinctus* does with the egg of *Prionony x thomæ.*

Since little is known on the hunting habits of *C. caeruleum,* it will not be amiss to append the following note: A specimen of this blue mud-dauber was found chasing a *Lycosa* spider. When first seen, the wasp was attempting to alight on the back of the spider. The spider eluded her, and she tried again and again, the spider darting this way and that. Sometimes the spider would get as far as a foot away, but by careful searching the pursuer would soon find it again. Finally the spider darted behind a small stone. The wasp in searching overlooked the spider and started off; immediately the spider went in the oppisite direction as fast as it could go. The wasp continued searching for a time, and at length came to rest on the ground six feet from where the spider was in hiding in the shadow of a board. The ground was dusty, and the spider was almost the color of the ground. It eluded the wasp.

* Trans. Acad. Science, St. Louis. 1918.

INSECT SCATOLOGY.

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Scatology, truly speaking, is applied to a branch of paleontology that treats of fossil excrement or coprolites. It is derived from scato or skato, Greek skor, meaning dung. From the same stem, the term scatophagous is derived for insects which feed upon dung or excrement. The present paper is concerned with the fecula or excrement of insects. The relation of insects to the dung of higher animals is another subject which has received considerable attention in the past. In rare instances, some of these insects might in the absence of dung, feed upon the fecula of their own species.

A review of the method of excrement disposal in the lower animals may help to explain this habit in the insects. In the lowest one-celled organisms, as the amoeba, the disposal of waste matter is not a complicated or specialized habit. The amoeba flows away from such material leaving it behind. In the paramoecium, discharges of undigested solid matter are made through a definite anal spot. As we ascend the animal scale, we find that the habit becomes more complex and more specialized. In the hydra, likewise in the jellyfish and the sea anemone (Coelenterata), and in the flat worms (Platyhelminthes) no anus is present and except in the parasitic Platyhelminetes, the feces are ejected through the so-called mouth. In the cestoda, there is no alimentary canal and the food is absorbed through the body wall and the waste material is removed by means of excretory tubes and the flame cells. Passing to the Nemathelminthes, and the star fishes (Echinodermata) we find the alimentary canal is complete, although simple, with an anus for the expulsion of the feces. In the round worms (Annelida) we find, for the first time, a well developed alimentary canal. In the Mollusca the disposal of excrement is unique. As it passes out of the anus it is carried away by means of a current of water flowing through the dorsal siphon. This brings us to the Arthropoda where the undigested food and waste material is gathered together into a mass in the posterior end of the alimentary canal and is egested through

the anus. Various digestive organs modify the nature and consistency of the fecula.

In the Araneida, the upper end of the pharynx is provided with a strainer to prevent solid food from entering the stomach. The most striking feature is a bladder like diverticulum on the dorsal wall of the mid and hind intestine which serves as a reservoir for fecal matter and is called the Stercoral pocket. All of the digestive organs of the spider tend to produce liquid or sem-liquid fecal discharges.

In all the Hexapoda, the general type of alimentary canal is the same, a tube extending from one end of the body to the other. The nature and composition of the fecula depends largely upon the type of digestive tract which in turn has been developed for the kind of food that must be digested and assimilated. Many social and parasitic insects feed upon highly concentrated foods and void little or no waste. Herbivors and scavengers take food in abundance but it is well digested in their long alimentary canals and only a small amount of waste is ejected. On the other hand, carnivorous insects have short alimentary canals and void considerable fecula. Continuous feeders, as Dendroctenus and the silk worm, tend to produce a continuous supply of fecula while intermittant feeders, as parasitic and predacious insects, must of necessity discharge their fecula at irregular intervals. The food, and in turn the fecula, may be further modified by accessory glands or structures. Jaws and gizzard tear or grind the larger and coarser particles of food. The glands of aphids and scale insects add secretions to the fecula which actually enriches it. Other organs may be responsible for removing moisture from the food thus resulting in drier fecula.

Fecal discharges occur in nearly all larval and nymphal stages of insects, although a few larvæ retain it until the final moult when it is voided. Most adults of the orders; Coleoptera, Hemiptera, Orthoptera, Neuroptera, Lepidoptera and probably other orders, take food and discharge waste material. Our knowledge of this habit in adult insects is still incomplete. There is, for example, a dispute whether the adult Cicada takes food although the alimentary canal in both males and females is complete and apparently well developed. Many of the Lepidoptera, on the other hand, take no food and in fact in some of the primitive forms the mouth is so reduced that they cannot take food.

The discharges from the alimentary canal of insects can be roughly divided into three classes. (1) Material which enters the mouth or accessory structures, as the infrabuccal pocket of ants, but does not pass through the alimentary canal. Such material includes the borings of some insects which are cast aside, the exudations of leaf-hoppers, grasshoppers, flies and other insects and the stomodael foods of bees, wasps, ants, and termites. None of these can properly be called fecula although they may undergo a change within the alimentary canal or may be cast away as waste material. (2) Excretions by the alimentary canal or its appendages, to which belong the secretions from salivary glands, the malpighian tubules and the secretions of honey dew by certain insects. (3) The ejection of fecula or true excrement, waste material or undigested food of an insect which passes through the alimentary canal and is expelled through the anus as pellets or as a semi-liquid. This is the material with which we are primarily concerned in this paper.

Before continuing, attention should be directed to the proper term that should be applied to the undigested food or waste material ejected through the anus of an insect. Numerous terms have been used, many of which are inadequate. Dung, feces, odure, and excreta are better applied to the waste material of higher animals. Excreta is especially poor as it refers, in its limited sense, to materials removed by urine, sweat or other secretions. Excrement is perhaps the best term that has been universally used but this is not truly entomological. Frass has been used somewhat but can be applied in a limited sense as it refers to the larval discharges and especially to the excreted pellets of caterpillars or to the refuse that wood-boring insects leave behind them. According to Craighead (1923)[1] frass may be of two sorts; (1) that which passes through the digestive tract of the insect, (2) that which is not eaten by the insect but cast aside by the mandibles much as a saw cuts its dust. Schwartz (1901)[2] describes the "saw-dust" ejected from the burrows of Simoxylon (Bostrichidæ) inhabiting mesquite which is as fine as flour. Frass has also been used quite generally to designate the waste material of leaf-mining insects. The term frass thus has an obscure and a limited use, and is actually inappropriate as it is the German for food, meat or pasture. Koth or auswurf would have been better

terms. Smith (1906)[3] defines the term "fecula" as the feces or excrement of insects. This is the proper term although it is seldom used.

It is remarkable to consider the different ways in which the fecula of insects are conserved, utilized, or disposed of, as the case may be in a particular species. In many insects the fecula are egested and cast aside as useless or even as obnoxious. On the other hand, certain species find it highly valuable as material for the construction of shelters, feeding cases, for growing fungi, or even as food for the larvæ. It is erroneous then to speak unreservedly of fecula as waste material.

It has been mentioned before that there are a few insects that do not eject fecula during the larval period. Some retain it only during the first instars while others retain it until the final moult, when it is voided. This habit has developed as a result of food and environmental conditions of the larvæ. The majority of these are parasitic forms living upon highly concentrated foods within hosts, cells, or chambers which must be kept clean. Such modifications of the usual method of fecal discharges occurs in the Hymenoptera in the families Prototrypidæ, Ichneumonidæ, Formicidæ, Vespidæ, Apidæ, and Cynipidæ. The retention of the fecula also occurs in the Dipterous family Hippoboscidæ, in the Neuropterous families; Myremeleonidæ, Osmylidæ, Sisyridæ, and Chrysopidæ and in two families in the Coleoptera; Meloidæ and Stylopidæ. Böoving (1909)[4] suggests that certain species of Donacia do not void any excrement, but was unable to prove it.

The great majority of insects discard their fecula as useless or as obnoxious. Some can apparently live in close proximity with such material with little or no discomfort. The anthomyid larva, *Pegomyia calyptrata* Zett., living as a miner in the leaves of Rumex, will illustrate this point. Other larvæ have developed means of avoiding it. Large numbers of caterpillars feeding in the open simply let it fall to the ground or crawl away and seek new feeding grounds. This reminds us of the primitive way in which the amoeba flows away from its waste material.

Insects that live within burrows or within stems or fruit are confronted with a more serious problem. The codlin moth larva pushes its borings from the burrow by means of it's head. Other caterpillars possess an anal comb by means of which they can toss the fecula away from the body. The most interesting

adaptations are found among the leaf-mining insects which seem destined to be closely confined with their fecula. A simple provision is found in the miners that deposit their frass in certain unoccupied portions of the mine. Hering (1926)[6] speaks of the living room and the dining room of such miners. Some deposit their frass in a line as they proceed in a forward direction. Many of the Lepidoptera and the Diptera have developed this manner. A variation of this method is found in the Gracilariidæ which deposit their dejections in the center of the mine and feed about the edges thus avoiding it. This habit was described by the writer (1924)[5] for the species *Phytomyza plumiseta*, (Diptera). In Parectopa and certain Diptera especially the Drosophilid leaf-miners, a digitate mine has been developed where the fecula are deposited in the distant fingerlike processes of the mine. The Lithocolletis avoid their fecula by vaulting the mine by means of silk. The Tischeridæ, Lyonetidæ, Cosmopterygidæ and certain other genera cut a round hole or a slit in the mine through which they eject their fecula. Hering (1926)[6] suggests that the legless leaf-mining Coleoptera and Hymenoptera were not able to develop this method of disposing of their fecula. Finally, certain miners, especially the Diptera, abandon their mines and construct new ones in fresh leaves. This habit probably arises from the lack of nourishment within a single leaf rather than an effort to avoid their fecula.

Many insects conserve their fecula for some essential purpose. The most unique and remarkable is that for food. The hen flea *Echidnophaga gallinacea* West., according to Parkman (1923)[7] finds it necessary for the development of their young. He says "the excreta of the adult are apparently necessary for the development of the young, and these latter have never been observed to feed on any other material." While few insects eat the fecula of their own species, many feed as scavengers on the fecula of other insects. This has been said of certain Stratiomyiidæ in the nests of Hymenoptera. Sharp (1895)[8] writes "Erne watched the Volucella larvæ in the nests [of a wasp] and he thinks that they eat the waste or dejection of the larvæ." He states that he kept Volucella larvæ and portions of the cells of Bombus, containing some larvæ and pupæ of the bees and some honey, but the fly larvæ did not, during some weeks, touch any of the bees or honey,

and ultimately died, presumably from starvation. Later they were confined with pupæ that had been broken and they immediately attacked them, showing that they act as scavengers.

An interesting exchange of food between the adult and the larva has been described in the Ants by Wheeler (1910)[9] as trophylaxis. The undigested food is egested as pellets from the mouth or strictly speaking the infrabuccal pocket of the adult. These pellets are placed by the worker in the so called trophothylax of the larva. Dr. Wheeler has described the formation of these pellets in detail which is worth quoting, "Liquids are, of course, merely imbibed and swallowed, but solid food is seized and crushed with the mandibles and the juices and the smaller particles licked up with the tongue, which is a roughened pad at the tip of the lower lip just anterior to the opening of the duct of the salivary glands. The small particles thus collected are carried back into a small chamber or sac, the infrabuccal pocket, which lies immediately below and anterior to the mouth opening." This pocket serves not only for the more solid particles of food but also for dirt, fungus spores etc., which the ant collects during her toilet operations. All solid or semi-solid particles are thus molded in the infrabuccal pocket. This habit of expelling pellets of undigested food from the anterior end of the alimentary canal is analagous to the expulsion of waste material from the so called mouth of the Hydra.

In the same category comes the exchange of food between the adult and larvæ of other insects as plant lice, scale insects, mealy bugs, leaf-hoppers and Chermidæ but in these the plant juices are passed through the alimentary canal. The cane sugars of the plant juices are split up to form invert sugar and the fecula are not only abundant but contain more invert sugar than the original sap and are eagerly sought by other insects.

Some insects use their fecula for the propagation of fungi on which their larvæ feed. The excrement in some and probably all the Ambrosia beetles is used to form beds to propagate a growth of fungus known as "Ambrosia." These larvæ do not digest the wood they excavate but pass it through the alimentary canal and it is cemented by means of fecula into yellowish pellets.

The ants show a more specialized use of their fecula in the propagation of fungus food. The last meal of the virgin queen

in the parental nest includes the mycelium of the particular fungus that the species of ant propagates. After mating and locating a place for a new nest the queen casts her pellet on the floor and it becomes the so called "spawn" for starting a new "Mushroom house," although the ants never allow the fungus to fruit. Here she lays her eggs and later the workers help to enlarge the nest and bring in pieces of leaves on which the fungus is grown.

A large number of insects use their fecula as a protective covering, especially in the larval stage. A few are said to cover their eggs with fecula or at least with regurgitated food. The egg of a Myriopod, *Spirobolus marginatus* was described by Barber (1915)[10] as laid in a mass of excrement but later he learned that the species laid its egg in a mass of regurgitated food. Sharp (1895)[8] gives the following record of the female of the group Camtosomes of the Chrysomelidæ which has a hollow near the extremity of the body and "when an egg is extruded the female holds it in this hollow by means of the hind legs, and envelops it with a covering said to be excrementitious." Chittenden (1904)[11] describes the egg laying habit in Chelepus. The eggs are laid in batches on the under side of the leaf and are covered with excrement. Some of the Blattidæ, which lay single eggs, without an ootheca, cover them with various kinds of foreign material even with their own fecula.

The larvæ of many insects are protected by their own fecula. This habit has been well summarized in the Coleoptera by Knab (1915)[12], "the habit of covering themselves with their own excrement occurs in the larvæ of several genera of Chrysomelidæ, of these the Blepharidæ and certain species of Lema and Crioceris are familiar examples. No such habits have been observed for the weevils and its occurrence is the more remarkable when one considers that in this group but a small proportion of the species have externally feeding larvæ." This habit occurs in two species of Ceutorhynchini; *Coelogaster* (*Dietzella*) *lituratus* Dietz., and *Perigaster obscurus* LeConte. The larva of *C. lituratus* feeds on *Oenothera biennis*. "The body is covered with a shiny secretion in which the excrement was imbedded and the latter was distributed so well that only the prominent laterial callosities were visible." It was suggested that the shiny material was secreted by the malpighian tubules. The larva is later inclosed in a cocoon of dry dung. In the case of

the larva of *Perigaster obscurus*, feeding on *Ludwigia alternifolia* L., the excrement is described as black and the secretion brown. The excrement is carried forward from the anus by peristalic movements of the body segments and accumulates on the anterior part of the larva and overhangs the head.

The larva of an European species, *Crioceris merdigera* has the anus so placed on its upper surface and so formed that when the excrement is voided it is pushed forward on the insect. Figuier (1869)[13] figures the larva of this beetle.

Other larvæ are provided with a forked process at the posterior extremity of the body known as a "feci-fork." This serves to carry the fecula to the back where they are retained. Several North American species of the genus Cassida and possibly Chelymorpha carry their fecula in this fashion, some only in the first instar, others carry it in all instars. Sharp (1895)[8] has given some interesting notes on certain exotic beetles which have developed this habit to an extreme degree. The larva of *Porphyaspis tristis*, a common insect in Bahia living on Cocoa-palm, covers itself with a very dense coat of fibers each many times the length of the body and elaborately moulded so as to form a round nest underneath which the larva lives. It is supposed that the fibers pass through the alimentary canal and subsequently stick together end to end. He goes on to state that the process of forming long fibers each from scores of pieces of excrement and giving them the appropriate curve, is truly remarkable.

The use of cast skins, resinous or waxy materials as in the Scale insects, which are as a matter of fact waste materials, can only be mentioned here in passing.

In the Lepidoptera we find numerous examples of larvæ protecting themselves by cases or feeding tubes constructed of fecula. Many species which feed between two leaves, incorporate waste material, silk and plant hairs thus forming more or less compact cases. The habit is too common to discuss in detail. The feeding tubes of the Bud moth, *Spilonota ocellana* D. & S., and the trumpet leaf crumpler *Mineola indigenella* Zell are familiar examples. Several species of Catestega have the peculiar habit of mining then constructing a case from their own fecula. *Gnorimoschema scutellariaeella* Cham., mines in the leaves feeding from a tube of frass. Apparently a single case is used which is attached at the smaller end. The larva of *Perophora sanquinolenta* constructs a portable

dwelling of fecula. This case is flattened on the sides and adapted to building. It is suspended on fine silken threads to relieve the larva of the burden of holding it but when it wishes to move to a new location these threads are cut and new threads are spun. Our North American species *P. melsheimeri* Harris, lives in a neat silken case covered with two pieces of leaf. Another variation is found in a species *Scolecocampa liburna* (Geyer) which was described by Beutenmuller (1902)[14]. This noctuid spins a tough cocoon of pieces of wood intermingled with fecula.

In the Diptera the habit of building larval feeding tubes of fecula is uncommon. Sharp (1895)[8] describes the habits of a Mycetophilid larva, *Epicypta scataphora* which has a remarkable structure on the dorsal part of the body by means of which the excrement is spread out and forms a case to envelope and shelter the larva. Ultimately the larval case is converted into a cocoon for transformation.

In the Hymenoptera we find some interesting cases of the use of the fecula in the construction of cocoons. *Sphex flavipennis* provisions its nest, a hole in the ground, with crickets. These are consumed and no excrement is ejected during the whole larval period. When the time for transformation approaches the entire contents of the alimentary canal is ejected and applied by means of the insects mouth to the interior of the cocoon giving it a dark polished lining. The exterior of the cocoon is constructed of silk. Wheeler (1915)[15] remarks that in the Ponerinæ and Camponotinæ the intestinal contents are usually deposited in the end of the cocoons.

Sharp (1895)[8] refers to observations by Vollenhwen who describes a larva of *Nematus compressicornis* (Tenthredinidæ) which feeds on poplar eating small holes in the leaves. As a means of protection, possibly from parasites, it constructs a palisade of small points of dried secretions from the mouth. Later these are eaten and new ones are formed.

A somewhat similar habit occurs in another Hymenopteron, Anthridium. The larva expells the fecula in small pellets which are fastened together with silk as they are voided and are suspended around the walls of its cell. Later these serve as an outline for the formation of the cocoon in which the metamorphosis is completed.

In the Coleoptera a few species have been reported to make cases of excrement. *Chlamys gibbosa* Fab. (*plicata* Fab.) and

possibly *Exema conspersa* var *dispar* Lac., as well as *E. gibber* Fab. possess this habit. The cases made by these species are very compact and resemble the pellets of certain caterpillars. They are certainly excellent examples of protective resemblance.

In passing, the resemblance of the species of Chlamys to pellets of caterpillars should be noted. Mr. F. C. Fletcher calls my attention to the fact that the tropical metallic species of Chlamys resemble the pellets of certain tropical Lepidoptera which are likewise of rather striking colors. There are many other cases of such resemblance. The cocoons of Cosinoptera resemble insect pellets. The adult of the moth, *Stenoma algidella* Walk., when resting on a green leaf, with its wings folded can easily be mistaken for the droppings of a bird.

A practical application of this study is found in the role of the fecula of insects in the dissemination of pathogenic organisms. It is well known that the alimentary canals of insects are often populated by numerous species of bacteria, fungi and certain parasitic worms, and that in many cases, the mouth serves as the portal for their entrance, which are taken with the ingested food. Glaser (1918)[16] in speaking of the bacterial disease, *Streptococcus disparis* of the Gipsy-moth, remarks, "Healthy animals naturally become infected by eating the food soiled by the feces of infected animals." This may be true of other Septicemia diseases as *Bacillus noctuarum* or *B. sphingidis*, although these diseases are also known to gain entrance to their hosts by contact. Fungi entomogeni have been traced through the mouth and alimentary canals of some insects. Speare (1920)[17] fed 25 Army worms upon clover leaves previously smeared with conodia from an agar culture of *Sorosporella uvella*. Later 16 of these larvæ succumbed to the disease.

Numerous parasitic worms are known to be transmitted by means of insects, but in these cases it is generally believed that the host takes the parasitic organism by eating the insect. Two classical examples might be cited. The tape worm *Hymenolepis diminuta* lives in its cysticercoid stage in a number of meal infesting insects as the tenebrionid beetles, certain earwigs and the moth *Asopia farinalis*. These insects take the eggs of the tape worm which are scattered in the excrement of mice and rats. The hosts in turn become infested by swallowing the infested insects. The eggs of the nematode parasite *Giganthorynchus hirudinaceus* are scattered in the feces of man

or pig and are ingested by the larvæ of the beetle *Cetonia aurata* or the cockchafer *Melontha vulgaris*.

It is evident that aquatic insects readily contaminate the water in which they live, when they discharge parasitic or pathogenic organisms with their fecula, and it is possible that other individuals may thus become infested. As far as the writer is aware, no one has attempted to determine the mortality of aquatic insects through this medium.

Finally the fecula of insects has a practical value to the entomologist. Very often it indicates the presence of insects after they have ceased feeding and disappeared. Sometimes the order or even the family of the culprit can thus be determined. A rough determination of the instars of an insect can be made by the size of the pellets for they likewise increase in size with each moult. In leaf-mining larvæ, a change in the manner of disposing of the so called "frass" often indicates a moult. In addition the fecula has a place in bio-chemistry as these are the by products of the insect and reveal something of the digestive processes.

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THE BEETLES OF THE GENUS PHYLLOPHAGA INHABITING SOUTH CAROLINA.

PHILIP LUGINBILL, PH. D.

INTRODUCTION.

The purpose of this paper is to give a systematic account of the species of Phyllophaga or May-beetles, collected in South Carolina, taking into consideration modern methods of classification.

Although the species of this group may often be recognized by external characters, it is now generally conceded that the chitinous structures of the genitalia offer a far more satisfactory basis for their specific identification, these organs alone often furnishing a sufficient basis for determination. The remarkable difference observable in these organs were not used for the recognition of species of North American beetles until applied by J. B. Smith (8)* to his study of this genus but had been used in certain European treatises. Very few new illustrations of May beetle genitalia have been published since Dr. Smith's paper of nearly forty years ago and for this reason it is thought important to include herewith figures of the genitalia of the species studied.

Thirty-one species have been collected in South Carolina, two of which are new to science. Several of the other species are quite rare. The descriptions of the new species are included in this paper.

Drawing and photographs of the adults of the commoner species are also given.

ACKNOWLEDGMENTS.

The drawings of the genitalia, as well as those of the adults, have been made by Miss Esther H. Hart, of the Bureau of Entomology, with the exception of illustrations a to e, inclusive of Fig. 16; a to e, inclusive of Fig. 21; a and b of Fig. 31 which were made by Mr. B. B. Fulton of Ames, Iowa. The photographs of the adults were made by Mr. J. G. Pratt, of the Bureau of Entomology.

* Reference is made by number to "Literature cited."

In making collections at Columbia, the writer was assisted by Mr. A. H. Beyer, who was connected with the Station at the time. Collections at Clemson College were made by Mr. B. F. Driggers, a student of the Institution; those at Georgetown, by Omer Ryan; and those at Greenwood by two corn club boys, Azell Walker and Marion Strawhorn. To Miss Lota Bootle, the writer is indebted for her faithfulness in

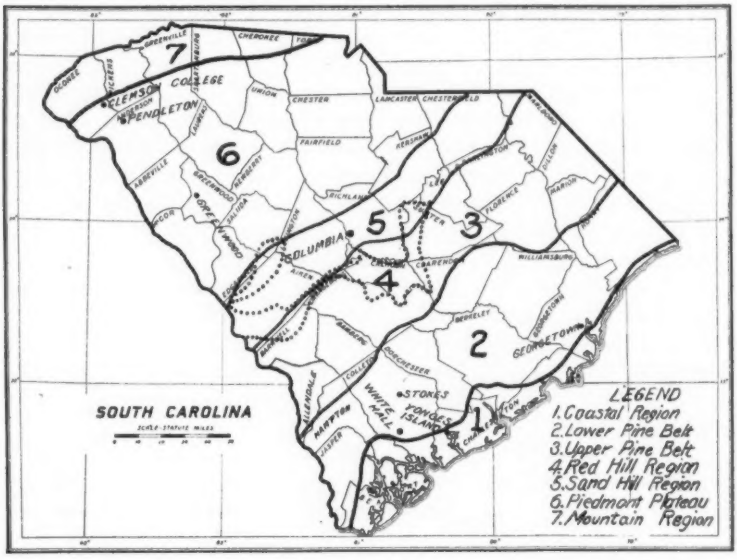

FIG. 1.

Map showing geographical regions of South Carolina and points at which May beetles were collected. (Adapted from Hammond's South Carolina).

supervising the operation of a lantern-trap for one year at White Hall, one year at Yonges Island, and for several years at Stokes. Prof. A. F. Conradi, of Clemson College, very kindly sent the College collection to the writer for inspection, thereby providing several species not in his collection.

To Prof. J. J. Davis, the writer is indebted for the identification of many of the species which were first collected.

Methods of Making Collections.

Various methods were utilized in making collections of adults, such as: (1) picking the beetles by hand, from the foliage of trees, shrubs, etc., or shaking such plants; (2) capturing them in lantern-traps, or, (3) under electric lights at residences, and in the streets. The first method was found to be the most satisfactory, as in this way the food plants of the beetles were ascertained. This method also resulted in the greatest number of captures. A three-celled electric flash-light was found to give the most satisfactory results for lighting purposes while picking. Very few specimens were taken at any one time in the lantern-trap, in fact, the number of captures in the traps as a whole was small; however, this method resulted in obtaining quite a number of different species, some of which were not taken otherwise. Very often beetles were picked from the foliage of plants close to a lighted lantern. The type of lantern that was used in most cases is shown in Figure 5, b, and is that commonly used in streets in towns where electric light or gas is not available. This lantern produced a rather large, strong flame, which it was thought should attract the beetles in fairly large numbers when on the wing. No flights of any great proportion were observed. It seems that although the weather was warm enough in the early evening to entice the beetles to come from the ground, later as it grew cooler they became stupified and did not fly about.

Points at Which Beetles Were Collected.

Collections were made at a number of points in the state between the sea coast and the mountains (see map, Fig. 1). The collections along the coast were made at White Hall, Yonges Islands and Georgetown. These points are almost at sea level. The taller vegetation consists of oaks, pines, persimmon and vines of various sorts. Figure 2, a and b; Figure 3, a and b; and Figure 4, are typical scenes of the country in this region. In the central part of the state the collections were made at Columbia, which has an altitude of about from 130 to 160 feet above sea level. The collecting ground at this place is a sand hill and is properly classed as belonging to the Sand Hill region of the state. The taller vegetation from which beetles were collected consisted of various kinds of oaks, hickory,

pine, blackberry and other trees, shrubs and vines. Figure 5-a, gives a view of a portion of the collecting ground. The taller vegetation in the foreground consists of various kinds of oaks,

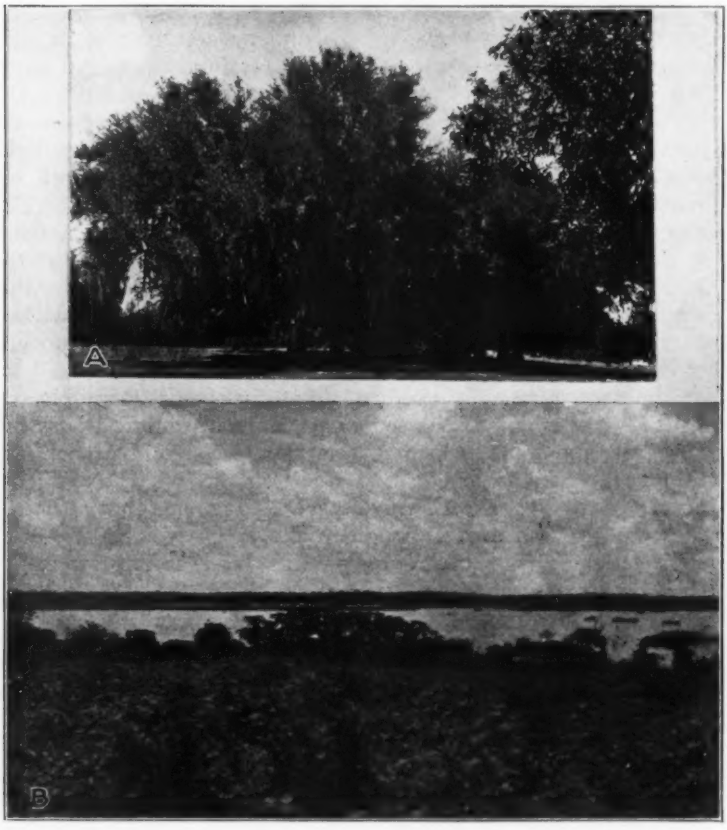

FIG. 2.

a, Live Oaks (*Quercus virginiana* Mill.) with Long Moss (*Dendropogon usneoides* (L) Raf.), White Hall, South Carolina; *b*, A submerged, abandoned rice field; White Hall, South Carolina. A lantern trap was placed near this point.

maple, hickory, grape, etc., *P. ulkei* Sm., *P. knochii* Gyll., and *P. tristis* Fab. were taken here. A number of specimens were taken near streams around Columbia, under conditions somewhat similar to those in what geographers call "The Upper

Pine Belt." In the Piedmont section, specimens were taken at Greenwood, Pendleton and Clemson College, having an altitude of from 600 to 800 feet above sea level. As would be expected, considering the rather wide range of altitude of the points given above, species found in the lower part of the state or on the coast are not found in the upper regions, and vice versa. It is also interesting to note that in the Upper Piedmont species occur that are common in the Middle West.

FIG. 3.

a, Deciduous oaks with Long Moss (*D. usneoides* (L.) Raf.) and other vegetation, Combahee Plantation, White Hall, South Carolina; *b*, A stream bordered with deciduous trees, oaks, persimmon, willow, etc., Combahee Plantation, White Hall, South Carolina.

DISCUSSION OF THE SPECIES.

Nomenclature.—There is quite a diversity of opinion among entomologists interested in this group, as to whether this genus of May-beetles should be called Lachnosterna or Phyllophaga. Dr. Hugh Glasgow (3), who has made an extensive study of this subject, has come to the conclusion that the proper generic name for this group is Phyllophaga. The writer has adopted his conclusions, including his synonymy.

Descriptions.—General descriptions of the adults of the species studied are not included in this paper, except descriptions of new species.*

In this paper emphasis has been placed on the superficial sexual characters including the descriptions of the genitalia. In the descriptions by the earlier writers the genitalia were entirely ignored.

FIG. 4.
Combahee River, Combahee Plantation, White Hall, South Carolina.

The term genitalia as used in these descriptions refers to the chitinized parts of the individual directly used in the process of copulation. In both sexes they are composed of two main portions, an anterior and a posterior. The anterior portion of the male structure is termed the telum, the posterior the claspers or lateral lobes. In the female, the anterior portion constitutes the genital plates, the posterior, the pubic process. This process is obsolete or wanting in a few species discussed in this paper.

Between the telum and the genitalia proper, in the male genitalia of several species there is an unchitinized area spanned

* The descriptions of old species which the author considered valid may be found in literature referred to.

by a thin membrane. This area assumes various shapes. In *lota* and *ephilida* it is circular; in *dispar* somewhat diamond-

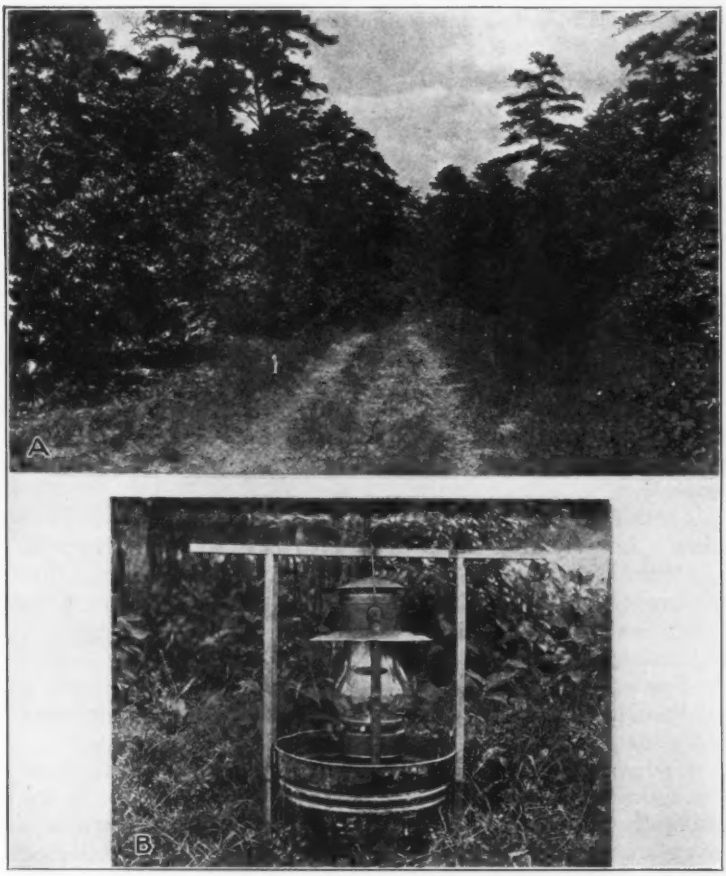

FIG. 5.

a, View of a portion of the collecting ground at Columbia, South Carolina, where many species of May beetles were collected, *b*, A lantern-trap. This type of trap was used at White Hall, Yonges Island, Stokes and Columbia, S. C.

shaped. This character may be used in the classification of the species.

In making the descriptions of the genitalia many difficulties were encountered. The claspers of the male genitalia in some species are conspicuously ornamented with incisions, protuberances and depressions, as in *hirsuta*, *lota*, etc. These are somewhat difficult to describe in plain terms. In other instances the claspers are united on the dorsum and have similar lateral faces as in *crenulata*, *nova*, etc.

Furthermore, some authors, in refering to the genitalia, consider them as separate from the body, and consequently the names they apply to the different aspects do not agree with the names used by those that consider them as in situ. The writer has adopted the latter system in this paper.

As an example of the differences of opinion mentioned above, Prof. Davis (1) labels one aspect "rear" and another "dorsal," which, according to other authors, should be just the reverse; the view of the female genitalia labeled "dorsal" by Prof. Davis is labeled caudo-ventral by other writers. It is not the writer's intention to criticise that system. This is mentioned merely by way of explanation so that those who may read the papers on this subject may understand them properly.

Localities.—This includes points at which specimens were taken. Lantern-trap captures are also listed in this paragraph.

Period of activity.—This extends from the date of the first appearance of the adults to date of their disappearance, as determined by actual collections and lantern-trap experiments. The maximum abundance refers to the period during which the beetles were out in the greatest numbers. Where only a few specimens of a species were taken this may be interpreted as the date of their capture or collection.

Host plants.—Under this heading are given the plants from which the beetles were collected. Properly speaking it is not absolutely proved that in every case the plant constitutes a host plant of the species, even though the species was collected from that plant. The beetles may have been merely resting when captured. When making collections it is not always possible to determine whether or not the beetles are feeding upon the plants from which they are taken. As a rule, however, it may be considered as a host though not always a preferred host. Since the specific name of the host plant is not known in every case, the genus to which it belongs is given in some cases.

Key to the Species.

In the introductory paragraph of this paper mention was made of the great importance that is being attached to the structure of the genitalia in the classification of the species in this genus. Although it is possible to classify a species by means of the figures, it has seemed advisable to include a general key which takes into consideration the form, size, and other structural characters, as an aid in the classification. This key should obviate somewhat the necessity of referring from figure to figure until the proper likeness is found.

Body pubescent above, the hairs abundant and conspicuous.
- Hairs long. From ½ to over 1 mm. in length.
  - Hairs in rows on the elytra and somewhat longer than on the head and prothorax; form dark brown to almost black; length, 18.3 mm. 1. *P. hirticula*
  - Hairs not in rows on the elytra, but evenly distributed.
    - Antennæ 9-jointed; form reddish brown; length, 15.6 mm....2. *P. hirsuta*
    - Antennæ 10-jointed.
      - Clypeus extending on to the eyes at base; specimens of large size, light to dark brown.
        - Body slightly pruinose, oblong-oval, slightly broader behind; length, 19 mm.....3. *P. parvidens*
        - Body not pruinose, oblong, the sides about parallel; length, 18.7 mm.....4. *P. crenulata*
      - Clypeus not extended to the eyes at base; specimens of small size, yellowish brown; length, 12 mm.....5. *P. tristis*
- Hairs short. Less than ½ mm. in length.
  - Surface of elytra distinctly pruinose; pubescence usually uniform; form robust; length, 22 mm.....6. *P. ilicis*

Body entirely glabrous above, or if pubescent, the hairs sparse, inconspicuous, and much less than ½ mm. in length.
- Antennæ 10-jointed.
  - Beetles ranging from 16 to 25 mm. in length.
    - Specimens of large size, usually over 19 mm. in length.
      - Highly polished.
        - Specimens reddish brown, sometimes dusky; length, 20 mm. 7. *P. ulkei*
        - Specimens piceous, rarely dark reddish brown.
          - Fixed spur of hind tibia in male moderately long and straight.
            - Clypeus only feebly emarginate and reflexed; sides of prothorax strongly arcuate; length, 20 mm.....8. *P. fervida*
            - Clypeus rather strongly emarginate and reflexed; sides of prothorax not strongly arcuate, usually markedly convex back of middle; length, 19 mm.....9. *P. fusca*
          - Fixed spur of hind tibia in male slightly curved and with a slight hook at tip; length, 22 mm.....10. *P. vehmens*
      - Not highly polished, sometimes somewhat shining, but often dull.
        - Specimens reddish brown; prothorax densely and coarsely punctured, punctures somewhat confluent; elytra lighter in color and finely punctured.
        - Specimens piceous, rarely reddish brown.
          - Females with abdomen inflated, the male somewhat less so, but markedly depressed on abdomen; length, 19 mm.....12. *P. luctuosa*

Female with abdomen not inflated; the depression on the abdomen of the male not so marked as above.
Elytra rugose; head and prothorax coarsely punctate; length, 2 mm.....13. *P. marginalis*
Elytra rugulose, prothorax and head finely punctate; length, 20 mm.....14. *P. anxia*
Specimens fairly large, ranging from 16 to 19 mm. in length.
Specimens lightly polished, reddish brown to black; length, 18 mm.....15. *P. foxii*
Specimens highly polished, reddish to dark chestnut brown; length, 16 mm.....16. *P. forsteri*
Beetles ranging from 10 to 16 mm. in length.
Specimens of medium size, 14 to 16 mm. in length.
Inner spur of hind tibia in male obsolete or wanting; form robust, reddish brown to dark brown; length, 15 mm. 17. *P. prununculina*
Inner spur of hind tibia in male present and at least one-half as long as the outer.
Specimens pruinose below as well as above.
Entire upper surface with pruinose coating; thorax dull; length, 15.8 mm.....18. *P. micans*
Elytra only pruinose above; thorax shining; length, 15 mm.....19. *P. deanii*
Specimens pruinose above only.
Clypeus feebly emarginate; form reddish brown to dark brown; length, 13 mm.....20. *P. impar*
Clypeus entire; form reddish to purplish, sometimes blackish; length, 15 mm.....21. *P. latifrons*
Specimens not pruinose.
Inner spur of hind tibia in male wanting; form slender, somewhat shining, reddish brown; length, 14 mm.....22. *P. glaberrima*
Inner spur of hind tibia in male present.
Specimens slightly polished, yellowish brown; length, 14 mm.....23. *P. ephilida*
Specimens highly polished, reddish brown to blackish brown; length, 15 mm.....24. *P. diffinis*
Specimens of small size, 10 mm. in length.
Beetles yellowish brown on elytra, with darker prothorax and a black head. 25. *P. gracilis*
Antennæ 9-jointed.
Specimens with reddish brown head, darker prothorax and yellowish brown elytra; length, 13 mm.....26. *P. quercus*
Specimens not pruinose.
Clypeus entire.
Beetles fairly large in size, reddish brown; length, 18 mm. 27. *P. clypeata*
Beetles small in size, 10 to 14 mm. in length.
Specimens yellowish brown, with darker head; slightly polished; length, 12.3 mm.....28. *P. lota*
Specimens reddish brown to piceous, highly polished; length, 10.5 mm.....29. *P. dispar*
Clypeus emarginate.
The emargination broad and shallow; elytra with short sparse hairs; form piceous; length, 15 mm.....30. *P. villifrons*
The emargination narrow and deep; form reddish brown; glabrous above; length, 15 mm.....31. *P. soror*

1. **Phyllophaga hirticula** Knoch.

Description: (Horn, 4, p. 266).

Male: Abdomen flattened on meson; penultimate segment transversely depressed near the caudal margin; ultimate segment, slightly depressed with a distinct ridge on either side.

Genitalia (Fig. 6, a, b, c, and d). Telum about as long as wide, rounded; posterior portion transversely ridged with a shallow groove on the meson along the longitudinal axis. Claspers distinctly separated, about as broad as high, widely spreading; left clasper the largest of the two, shell-shaped, slightly involute on the upper caudal margin, slightly invaginated in the lower cephalic margin, forming a blunt tip; right

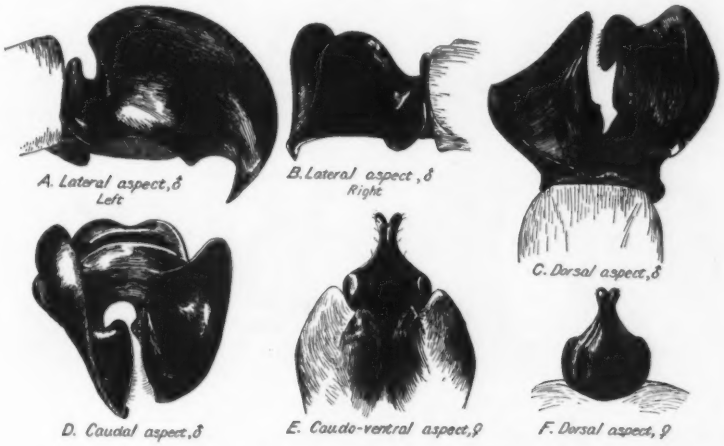

FIG. 6. *Phyllophaga hirticula* Knoch. (Genitalia).
a, Lateral, ♂, Left; *b*, Lateral, ♂, Right; *c*, Dorsal, ♂; *d*, Caudal, ♂; *e*, Caudo-ventral, ♀; *f*, Dorsal aspect, ♀.

clasper, involute in the cephalo-ventral region, producing two lobes, an inner and an outer with a blunt tip, from the rear this clasper represents the letter J.

Female: Genitalia (Fig. 6, e and f). Genital plates somewhat longer than wide; the suture between the plates on the meson well defined; the distal portions somewhat separated and pointed. Pubic process somewhat flask-shaped, emarginate at apex; proximal portion broad, the sides well rounded, the caudo-ventral region deeply concave; distal portion much constricted, bent dorsad.

Not common. Taken at Columbia, Clemson College and Pendleton. Not found in lower part of the state. Taken in lantern-trap at Columbia. Active, April 8 to May 15.

HOST PLANTS—White-heart Hickory (*Carya alba* (L) K. Koch.)
Common Perismmon (*Diospyros virginiana* L.)
River Birch (*Betula nigra* L.)
Black Jack Oak (*Quercus marilandica* Muench.)
Elm (*Ulmus* sp. probably *alata* Michx.)

2. **Phyllophaga hirsuta** Knoch.

Description: (Horn, 4, p. 260).

Male: Abdomen slightly flattened on the meson; penultimate segment depressed near the caudal border, with a slight elevation in front of the depression and on the sides; depression scabrous; ultimate segment depressed.

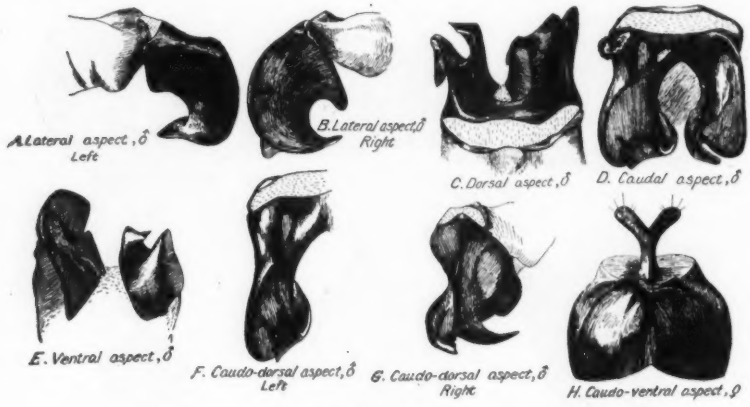
A. Lateral aspect, ♂ Left
B. Lateral aspect, ♂ Right
C. Dorsal aspect, ♂
D. Caudal aspect, ♂
E. Ventral aspect, ♂
F. Caudo-dorsal aspect, ♂ Left
G. Caudo-dorsal aspect, ♂ Right
H. Caudo-ventral aspect, ♀

FIG. 7. *Phyllophaga hirsuta* Knoch. (Genitalia).
a, Lateral, ♂, Left; *b*, Lateral, ♂, Right; *c*, Dorsal, ♂; *d*, Caudal, ♂; *e*, Ventral, ♂; *f*, Caudo-dorsal, ♂, Left; *g*, Caudo-dorsal, ♂, Right; *h*, Caudo-ventral aspect, ♀.

Genitalia (Fig. 7, a to g, inclusive). Telum somewhat over 2 mm. long, somewhat flattened on the dorsum in the posterior region; posterior border almost straight. Claspers distinctly separated, very dissimilar; left clasper slightly involute on the dorsum, deeply invaginated in the lower anterior border, producing a claw-like tip pointing cephalad; right clasper similarly invaginated and supplied with claw-like tip, but in addition a curved hook on the inner face of the caudal region. From the rear claspers are deeply channeled along inner margins.

Female (Fig. 36, b,): Penultimate and ultimate segments supplied with sparsely scattered, long, stiff hairs.

Genitalia (Fig. 7, h). Genital plates about 3mm. across, bulging far apart, converging somewhat distad and producing a ledge dorsad of which the pubic process arises. Pubic process about 1 mm. long, simple, distinctly Y-shaped, with the two diverging legs distad and somewhat hairy at their apices.

Taken at Columbia and Clemson College; common at latter place. Not found in lower part of state. Several specimens taken in lanter-trap at Columbia. Active, April 5 to May 10. Maximum abundance, latter part of April.

HOST PLANTS—Oak (*Quercus* sp.)
White Ash (*Fraxinus americana* L.)
Red Oak (*Quercus rubra* L.)
Black Scrub Oak (*Quercus ilicifolia* Wang.)
White Oak (*Quercus alba* L.)
Black Oak (*Quercus velutina* Lam.)

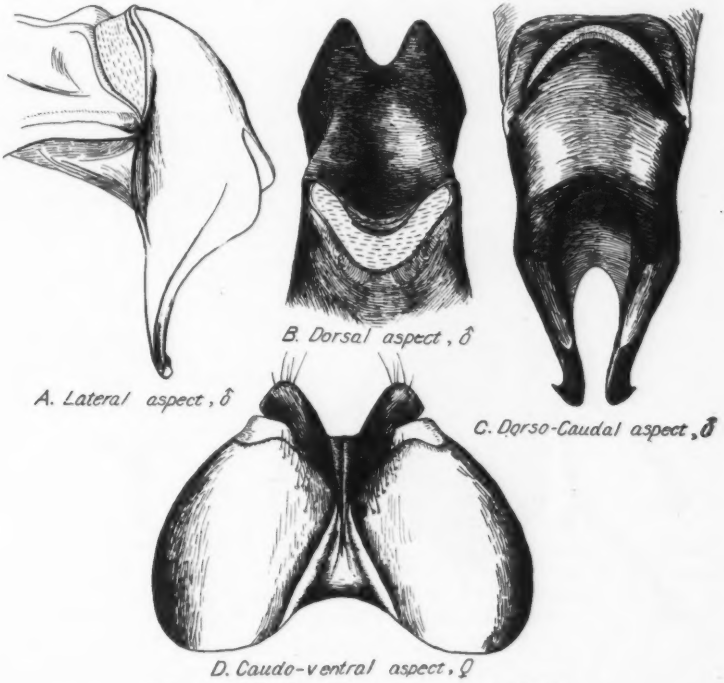

FIG. 8. *Phyllophaga parvidens* Lec. (Genitalia).
a, Lateral, ♂; *b*, Dorsal, ♂; *c*, Dorso-caudal, ♂; *d*, Caudo-ventral aspect, ♀.

3. **Phyllophaga parvidens** LeC.

Description: (Horn, 4, p. 275).

Male: Abdomen finely pubescent, rounded on the meson, except in region of penultimate and ultimate segments, where it is slightly depressed.

Genitalia (Fig. 8, a, b, and c). Telum 5 mm. long, the posterior end strongly concave. Claspers similar, united on the dorsum, which is smooth and markedly concave on the anterior end to fit the concavity in the telum; posterior end on the dorsum has a deep rounded incision; claspers long extended laterally; viewed from the sides the claspers show a decided concavity along the caudal margins, producing long, narrow, blunt tips; distal opening somewhat ovate.

Female: Genitalia (Fig. 8, d). Genital plates, 3.5 mm. across, not quite as long as wide, touching on the meson at their distal ends. Pubic process simple, composed of a broad plate, the distal end with a V-shaped incision, producing a broadly rounded reflexed tip on either side; incision narrowly rounded at base.

Very rare. Taken at Georgetown. No specimens from any other point in the state. Active, May 2 to May 8.

HOST PLANT—Water Oak (*Quercus nigra* L.).

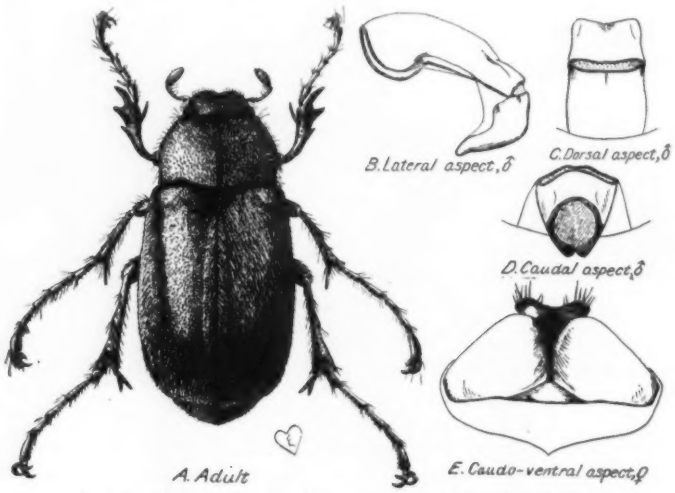

FIG. 9. *Phyllophaga crenulata* Frohl. (Adult and genitalia).
a, adult, ♂; *b*, Lateral, ♂; *c*, Dorsal, ♂; *d*, Caudal, ♂; *e*, Caudo-ventral aspect, ♀.

4. **Phyllophaga crenulata** Frohl.

Description: (Horn, 4, p. 272).

Male (Fig. 9, a). Abdomen rounded on the meson; penultimate segment feebly concave; ultimate segment depressed.

Genitalia (Fig. 9, b to d inclusive). Telum about 3 mm. long, with a transverse depression near the posterior border; border straight. Claspers, united on dorsum and venter, simple, unornamented, as long

as wide; anterior borders sloping distad on the sides, forming a narrow ventral region about half as long as the dorsal one; caudo-ventral border is emarginate in the middle; distal opening circular.

Female: Genitalia (Fig. 9, e). Genital plates about 1 mm. long and about as much across, meeting in the proximal region, widely diverging distad; distal extremities depressed on the meson, disclosing the process above. Pubic process thin, flat, about two-thirds as long as wide, concave on the venter, protruding only slightly from the distal portion of the plates, broadly emarginate in the center of the distal extremity; outer edges are rounded and bear a few short hairs.

Found throughout the state. Fairly abundant in the Sand Hill region. Taken at White Hall, Yonges Island, Columbia, Pendleton and Clemson College. This is one of the commonest species taken in lantern-trap in Columbia. Active, April 10 to June 25. Maximum abundance April 15 to May 15.

HOST PLANTS—White-heart Hickory (*Carya alba* (L) Koch.)
Common Persimmon (*Diospyros virginiana* L.)
Black Jack Oak (*Quercus marilandica* Muench.)
Black Scrub Oak (*Quercus ilicifolia* Wang.)
Black Oak (*Quercus velutina* Lam.)
Elm (*Ulmus* sp. probably *alata* Michx.)
Common Elder (*Sambucus canadensis* L.)
River Birch (*Betula nigra* L.)
Haw (*Crataegus* sp. probably *C. tomentosa* L.)
Loblolly Pine (*Pinus taeda* L.)
Choke Cherry (*Prunus virginiana* L.)
Wild Grape (*Vitis* sp. probably *V. rotundifolia* Michx.)
Wild Rose (*Rosa* sp.)
Hackberry (*Celtis smallii* Beadle)
Black Walnut (*Juglans nigra* L.)
Green Briar (*Smilax* sp.)

5. **Phyllophaga tristis** Fab.

Description: (Horn, 4, p. 286).

Male: Abdomen slightly flattened on the meson; penultimate segment with a distinct ridge on the anterior portion of the segment; ultimate segment depressed, the anterior border slightly elevated.

Genitalia (Fig. 10, b to d, inclusive). Telum 3 mm. long, slightly concave on the posterior border. Claspers united, not only on the dorsum but also on the venter; caudo-ventral border is supplied with two teeth somewhat separated, while the cephalo-ventral border bears two sharp teeth close together; distal opening somewhat circular, extending dorsad and ending in a sharp angle on meson.

Female (Fig. 10, a): Genitalia (Fig. 10, e). Simple, consisting of two genital plates, about 1.5 mm. long and about as wide; heavily chitinized at their distal ends and somewhat hairy; plates come together on the meson, are flat, and deeply, obliquely incised on the meson near the caudal extremities; sometimes the plates are almost colorless except at their distal ends.

Common in central part of the state. Taken at Columbia and Clemson College. No specimens from the southern part of the state. Not often taken in lantern-trap. Active, April 5 to April 30. Maximum abundance, April 10 to 20.

HOST PLANTS—Black Jack Oak (*Quercus marilandica* Muench.)
Water Oak (*Quercus nigra* L.)
Common Persimmon (*Diospyros virginiana* L.)
Land Blackberry (*Rubus cuneifolius* Pursh.)
Maple (*Acer* sp.)
Sumach (*Rhus* sp. probably *R. copallina* L.)
White Ash (*Fraxinus americana* L.)
Apple (*Pyrus malus* Linn.)
Choke Cherry (*Prunus virginiana* L.)
Elm (*Ulmus* sp. probably *alata* Michx.)
Chickasaw Plum (*Prunus angustifolia* Marsh.)
Haw (*Crataegus* sp. probably *C. tomentosa* L.)
White-heart Hickory (*Carya alba* (L) K. Koch.)
Farkleberry (*Vaccinium arboreum* Marsh.)

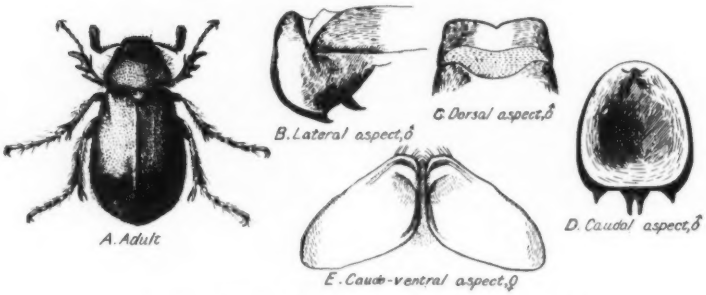

FIG. 10. *Phyllophaga tristis* Fab. (Adult and genitalia).
a, Adult, ♀; *b*, Lateral, ♂; *c*, Dorsal, ♂; *d*, Caudal, ♂; *e*, Caudo-ventral aspect, ♀.

6. **Phyllophaga ilicis** Knoch.

Description: (Horn, 4, p. 268).

Male: Abdomen flattened on the meson; penultimate segment concave and scabrous with an oblique ridge on either side; ultimate segment depressed.

Genitalia (Fig. 11, a to d inclusive). Telum about 6 mm. long with a straight but somewhat raised posterior border. Claspers distinctly separated, widely spreading, expanse 2.5 mm. Left clasper, shell-like with a spherical incision on the dorsum; upper lateral portion of clasper is broad, but gradually narrows ventrally and ends in a blunt tip, augmented by a slight invagination of the lower anterior border. Right clasper somewhat scoop-shaped from the rear, appearing as two thin lobes which extend ventrad and form a broadly rounded reflexed tip.

Female: Genitalia (Fig. 11, e). Genital plates about 2 mm. long, about as wide as long, meeting on the meson, deeply depressed along the

suture line; inner distal corners pointed; plates extend laterad and surround the pubic process, supplied at these points with conical cavities or gullies. Pubic process 2 mm. long, half as wide as long, the proximal portion the widest and deeply concave on the ventro-meson; sides rounded and straight, becoming much constricted distad and ending in a flattened tip which is somewhat notched; emargination is produced by a groove which leads from the concavity of the proximal portion to the apex of the process.

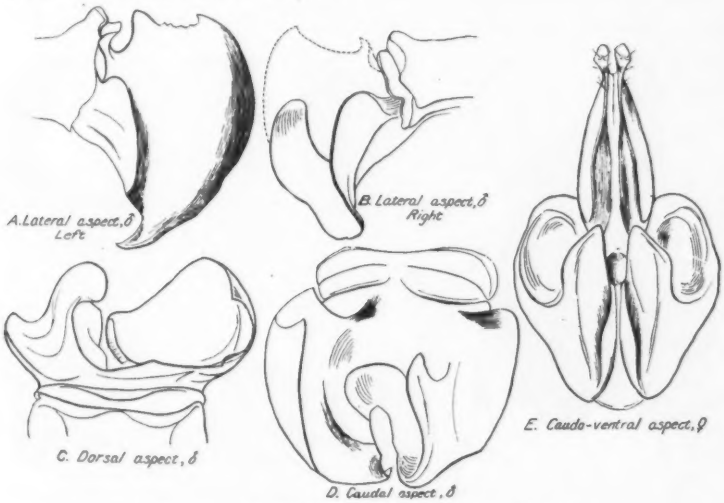

FIG. 11. *Phyllophaga ilicis* Knoch. (Genitalia).
a, Lateral, ♂, Left; *b*, Lateral, ♂, Right; *c*, Dorsal, ♂; *d*, Caudal, ♂; *e*, Caudo-ventral aspect, ♀.

Rare. Taken at Columbia, Pendleton and Clemson College. Not found in the southern part of the state. Only one specimen taken in lantern-trap in Columbia. Active, April 25 to May 25.

HOST PLANT—Black Jack Oak (*Quercus marilandica* Muench.)

7. **Phyllophaga ulkei** Smith.

Description: (Smith, 7, p. 94).

Male: Abdomen flattened, somewhat dished on the meson; penultimate segment transversely ridged on the caudal border, the ridge scabrous in the concavity.

Genitalia (Fig. 12, b to e inclusive). Telum about 5 mm. long, the posterior portion polished and undulating, its border convex; membraneous area lenticular in outline. Claspers very similar, united on the dorsum, about 2 mm. long, as wide as long; caudal borders rounded,

flattened ventrally, ending in notched apices, the sides being somewhat twisted; lateral sides of the claspers in front of the rounded portions, depressed, more so anteriorly than posteriorly. Genitalia resemble somewhat those of *fusca*, however, the rounded borders on the caudal region are wider, the lateral depressions more shallow in *ulkei* than in *fusca*. The space between the claspers represents a letter O in *fusca*, in *ulkei* an oval figure.

Female (Fig. 12, a). Very dark brown, almost black on the abdomen. Genitalia (Fig. 12, f). Genital plates about 2 mm. long, 1.5 mm. wide, distinctly separated. Pubic process composed of two stems about

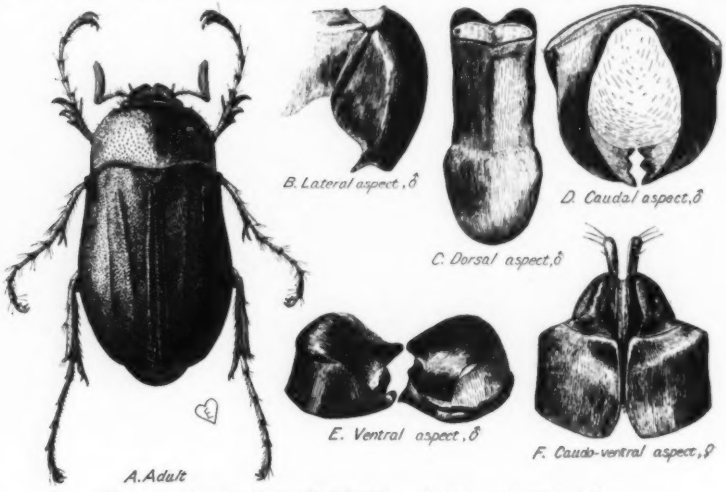

FIG. 12. *Phyllophaga ulkei* Smith. (Adult and genitalia).
a, Adult, ♀; *b*, Lateral, ♂; *c*, Dorsal, ♂; *d*, Caudal, ♂; *e*, Ventral, ♂; *f*, Caudo-ventral aspect, ♀.

1.5 mm. long, somewhat bat-shaped, inserted in between the plates for two-thirds their length; inserted portions united; exserted portions slightly separated, diverging near the apices, which are rounded, knob-shaped and bear a few hairs.

Common at Columbia. Also taken at Clemson College. Not found in the lower part of the state. A common species taken in lantern-trap in Columbia, also taken under electric lights at same place. Active, March 25 to May 25. Maximum abundance April 10 to April 25.

HOST PLANTS—Black Jack Oak (*Quercus marilandica* Muench.)
Water Oak (*Quercus nigra* L.)
White-heart Hickory (*Carya alba* (L) K. Koch.)
Common Persimmon (*Diospyros virginiana* L.)

Elm (*Ulmus* sp.)
Land Blackberry (*Rubus cuneifolius* Pursh.)
Farkleberry (*Vaccinium arboreum* Marsh.)
Flowering Dogwood (*Cornus florida* L.)
Apple (*Pyrus malus* L.)
Sweet Gum (*Liquidamber strychiflua* L.)
Sumac (*Rhus* sp. probably *R. copallina* L.)
Maple (*Acer* sp.)
White Ash (*Fraxinus americana* L.)

8. **Phyllophaga fervida** Fab.

Description: Fab., 2, p. 36; Smith, 6, p. 183).

Male: Abdomen somewhat dished on the meson; penultimate segment crossed transversely by a curved ridge, caudad of which is a deep depression somewhat undermining the ridge; ultimate segment concave.

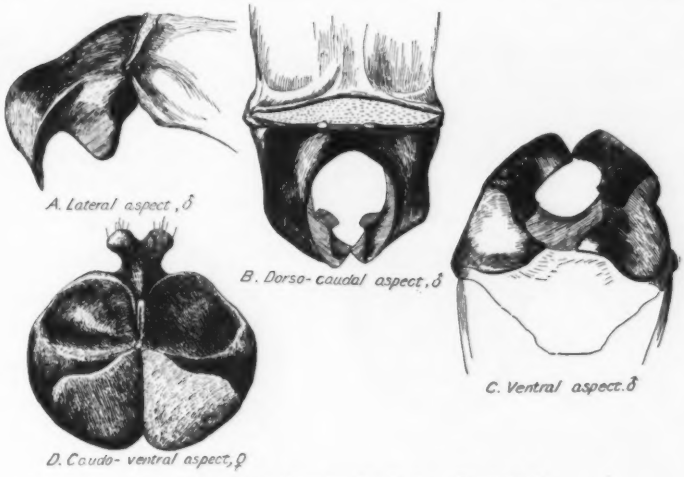

FIG. 13. *Phyllophaga fervida* Fab. (Genitalia).
a, Lateral, ♂; *b*, Dorso-caudal, ♂; *c*, Ventral, ♂; *d*, Caudo-ventral aspect, ♀.

Genitalia (Fig. 13, a to c, inclusive). Telum 5 mm. long, the posterior margin slightly raised, the border somewhat concave. Claspers similar, united in the upper caudal region; caudal borders much flattened ventrad and terminating into notched apices; inner margins touching in the caudo-ventral region; lateral sides of claspers much depressed, the depression somewhat deeper on the right than on the left clasper; distal opening somewhat ovate.

Genitalia resemble those of *anxia* somewhat, but in the latter species the caudal borders are much narrower and the apices are entire.

Female: Genitalia (Fig. 13, d). Genital plates 2.5 mm. across, touching on meson, with an incision near the middle of each plate;

distal portions much depressed in the center. Pubic process composed of a short, broad, proximal portion and two short, widely diverging stems; resembles the letter Y somewhat.

Very rare. Taken at Greenwood. No specimens from any other point in the state. Active, April 13.

HOST PLANTS—Loblolly Pine (probably *Pinus taeda* L.)

9. **Phyllophaga fusca** Frohl.

Description: (Horn, 4, p. 245).

Male: Abdomen flattened on the meson; penultimate segment transversely ridged, the ridge scabrous and sometimes bearing a few hairs on the sides; ultimate segment, depressed on or near the caudo-ventral border, anterior border sometimes slightly ridged.

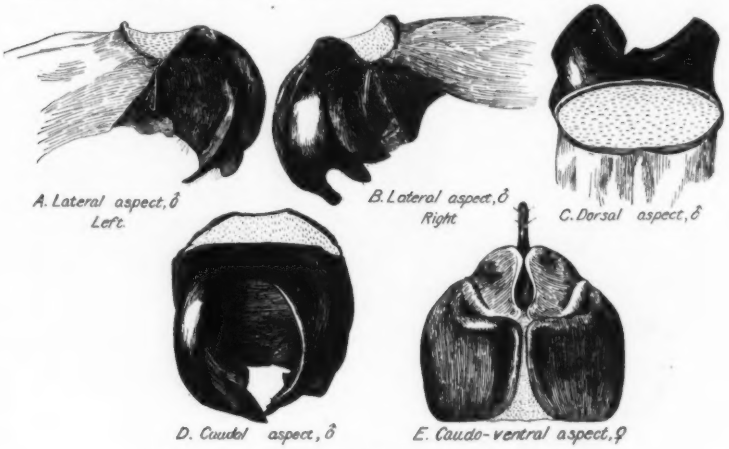

FIG. 14. *Phyllophaga fusca* Frohl. (Genitalia).
a, Lateral, ♂, Left; *b*, Lateral, ♂, Right; *c*, Dorsal, ♂; *d*, Caudal, ♂; *e*, Caudo-ventral aspect, ♀.

Genitalia (Fig. 14, a to d, inclusive). Telum 5 mm. long, surface undulating; posterior border concave and joined to the genitalia proper by a thin membrane, the area spanned by this membrane lenticular in outline. Claspers united on the dorsum, very similar, the expanse about twice the height; posterior borders rounded, the rounded portions widening and flattening caudo-ventrad into V-shaped apices; the rounded and flattened area of the left clasper is somewhat wider than that of the right clasper and markedly depressed in front; distal opening assumes outline of letter O.

Female: Black on the abdomen, slightly flattened on the meson.

Genitalia (Fig. 14, e). Genital plates 3 mm. wide, converging caudad, much wrinkled in the caudal region. Pubic process a short

straight stem about 1 mm. long, rounded at apex; exserted for one-half its length.

Common in upper Piedmont. Taken at Clemson College and Pendleton. No specimens from the central and southern part of the state. No specimens captured in lantern-trap. Period of activity not known.

HOST PLANTS—Unknown.

10. **Phyllophaga vehemens** Horn.

Description: (Horn, 4, p. 244).

Male: Abdomen depressed on the meson; penultimate segment with a curved ridge along the posterior border, the crest of ridge sharp-

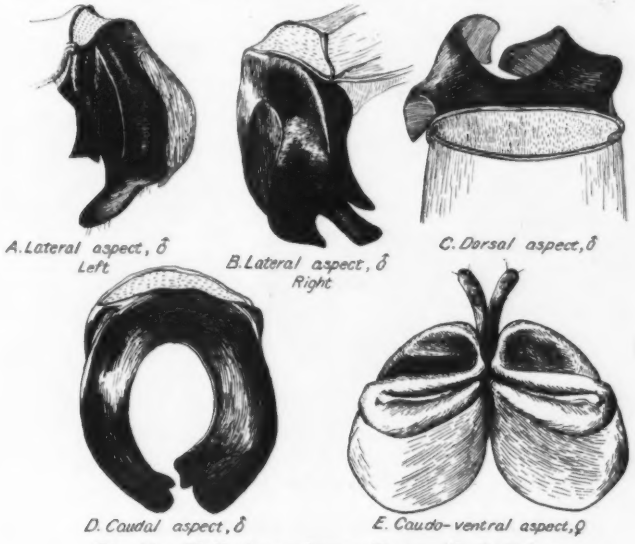

FIG. 15. *Phyllophaga vehemens* Horn. (Genitalia).
a, Lateral, ♂, Left; *b*, Lateral, ♂, Right; *c*, Dorsal, ♂; *d*, Caudal, ♂; *e*, Caudo-ventral aspect, ♀.

angled on the sides and somewhat rounded on the meson. Inner spur of hind tibia almost as long as the outer and hooked at tip.

Genitalia (Fig. 15, a to d, inclusive). Telum slightly concave on the posterior border. Claspers, dissimilar, united on the dorsum; caudal borders broad and flat; apices deeply depressed, the depression more pronounced on the right side. Left clasper more roundly depressed on the lateral side than the right clasper, the depression producing a bilobed structure; distal opening somewhat circular.

Female: Genitalia (Fig. 15, e). Genital plates 3 mm. across, not quite as long as wide, with narrow but very deep depressions across the middle; distal portions deeply concave. Pubic process composed of two slender diverging stems arising from between the distal parts of the plates; inserted portions of stems united; space between the exserted portions of the stems V-shaped.

Taken at Columbia. No specimens from any other part of the state. One specimen taken in lantern-trap in Columbia. Active, April 27.

HOST PLANTS—Unknown.
REMARKS—Only one specimen of this species collected in the state.

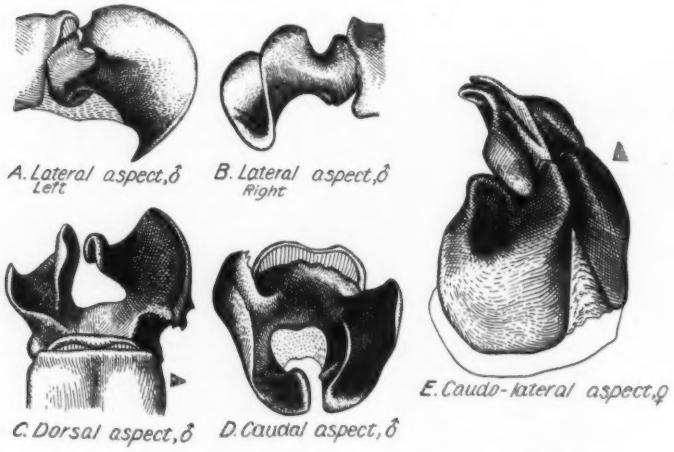

FIG. 16. *Phyllophaga knochii* Schoen. Gyll. (Genitalia).
a, Lateral, ♂, Left; *b*, Lateral, ♂, Right; *c*, Dorsal, ♂; *d*, Caudal, ♂; *e*, Caudo-lateral aspect, ♀.

11. **Phyllophaga knochii** Schoenherr and Gyllenhal.

Description: (Horn, 4, p. 257).

Male: Abdomen flattened on the meson; penultimate segment with a deep depression along the caudal margin, the anterior rim of this depression being scabrous and the sides plicate; ultimate segment markedly depressed, less so on the meson than on either side.

Genitalia (Fig. 16, a to d, inclusive). Telum 7 mm. long, the anterior portion broader and longer than the posterior one; posterior portion transversely depressed in the middle, the caudal end somewhat raised, the border straight. Claspers open, widely spreading on the dorsum, expanse twice the length. Left clasper thin, shell-shaped, the upper caudal portion slightly involute, the ventral face invaginated, producing a blunt tip; at base of this clasper on upper side is a circular

incision. Right clasper, scoop-shaped from the rear, with a blunt tip bent ventrad, upper caudal margin somewhat involute; the upper base moderately incised.

Female: Genitalia (Fig. 16, e). Genital plates 2.5 mm. wide, and about 3 mm. long, with the lateral sides rounded; caudal border incised to receive the pubic process, deeply depressed along the border of the incision. Pubic process composed of a broad proximal portion and a short narrow stem which is notched at the apex; ventral region deeply depressed; in outline the process somewhat resembles a flask.

Not common. Taken at Columbia. No specimens from any other point in the state. Several specimens taken in the lantern-trap at Columbia. Active, April 15 to May 5.

HOST PLANTS—Black Jack Oak (*Quercus marilandica* Muench.)
White-heart Hickory (*Carya alba* (L) K. Koch.)
Maple (*Acer* sp.)
Hackberry (*Celtis smallii* Beadle).

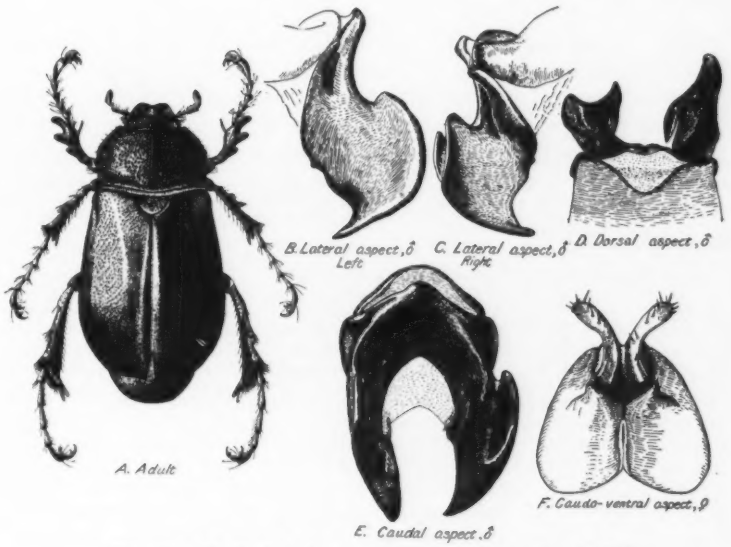

FIG. 17. *Phyllophaga luctuosa* Horn. (Adult and genitalia).
a, Adult, ♀; *b*, Lateral, ♂, Left; *c*, Lateral, ♂, Right; *d*, Dorsal, ♂; *e*, Caudal, ♂; *f*, Caudo-ventral aspect, ♀.

12. **Phyllophaga luctuosa** Horn.

Description: (Horn, 4, p. 254).

Male: Abdomen flattened on the meson; penultimate segment with a curved ridge and a deep depression behind; ultimate segment, depressed, the depression scabrous.

Genitalia (Fig. 17, b to e, inclusive). Telum about 5 mm. long, with a deep transverse depression in the posterior region, the border slightly concave. Claspers distinctly separated, not united on the dorsum. Left clasper flat, thick, with a marked invagination of the lower inner face, producing a ledge, extending caudo-laterally and ending in a blunt tip. Right clasper deeply invaginated on the lower inner face, and much depressed above, producing a concavity; the depression is obliterated caudad and the clasper ends in a wide, blunt, thin tip.

Female (Fig. 17, a). Usually darker and somewhat larger than the male. Abdomen rounded, somewhat inflated, finely and sparsely punctured, polished.

Genitalia (Fig. 17, f). Genital plates about 2 mm. long, about as wide, the edges somewhat raised along the suture line and colorless; plates extend laterad and caudad, forming an auricle-like distal region on either side. Pubic process composed of two stout stems, attached to the same base and touching or almost so in the proximal region, widely diverging distad.

This is the commonest species in the central part of the state. It is apparently a Sand Hill species. Common to Columbia; several specimens from Greenwood, Pendleton and Clemson College. No specimens from the lower part of the state. Specimens taken in lantern-trap at Columbia, though not frequently considering the abundance of the species at this place. Active, March 25 to July 10. Maximum abundance April 10 to 30.

HOST PLANTS—Loblolly Pine (*Pinus taeda* L.)
Georgia Pine (*Pinus palustris* Mill.)
Water Oak (*Quercus nigra* L.)
Black Jack Oak (*Quercus marilandica* Muench.)
White-heart Hickory (*Carya alba* (L) K. Koch.)
Elm (*Ulmus* sp. probably *alata* Michx.)
Chickasaw Plum (*Prunus angustifolius* Marsh.)
Wild Grape (*Vitis* sp. probably *V. rotundifolia* Michx.)
River Birch (*Betula nigra* L.)
Haw (*Crataegus* sp. probably *C. tomentosa* L.)
Sweet Gum (*Liquidamber atrychiflua* L.)

13. **Phyllophaga marginalis** LeC.

Description: (Horn, 4, p. 250).

Male: No specimens of this sex in the writer's collection.

Female: Abdomen rounded on the meson; penultimate segment crossed with a transverse ridge caudad of which is a deep depression.

Genitalia (Fig. 18, a). Genital plates about 1 mm. across and about twice as long, depressed along the suture line, which is very distinct; in caudad region plates form a cup-like depression into which the pubic process fits very snugly. Pubic process over 1 mm. long,

with a broad proximal portion and two short, broad, twisted, diverging stems which are truncate at their apices; area between the stems somewhat V-shaped.

This species is rare. Only one specimen was taken in the state. This was collected at Columbia. Active, April 22.

HOST PLANT—Loblolly Pine (*Pinus taeda* L.)

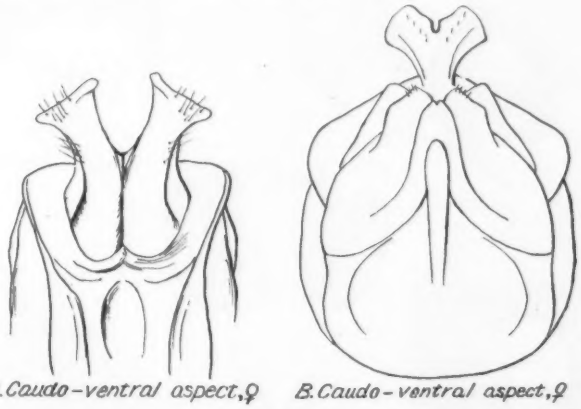

FIG. 18. *Phyllophaga marginalis* Lec. (Genitalia). *Phyllophaga villifrons* LeC. *a*, Caudo-ventral aspect, ♀; *b*, Caudo-ventral aspect, ♀.

14. **Phyllophaga anxia** LeC.

Description: (LeConte, 5, p. 226).

Male: Abdomen flattened on the meson; penultimate segment transversely crossed by a curved scabrous ridge, behind which the segment on either side is much depressed; ultimate segment depressed.

Genitalia (Fig. 19, a to e, inclusive). Telum 5 mm. long, the posterior border slightly convex; membranous area somewhat lenticular in outline. Claspers very much alike, united on the dorsum; caudal borders much flattened, with depressions in the middle; lower lateral and latero-ventral faces much depressed; caudal flattened portions overhanging producing ledges; tips point cephalad; distal opening represents letter U inverted with legs slightly diverging.

Female (Fig. 36, a).

Genitalia (Fig. 19, f and g). Genital plates rounded on the sides; posterior portion ridged through the middle with depression on either side. Pubic process 1 mm. long, composed of two broad and somewhat rounded stems, inserted in between the plates for about one-half of their length; inserted portions united; exserted portions diverging, apices truncate and somewhat reflexed; space between exserted portions V-shaped.

Found throughout the state; fairly common. Taken at Georgetown, Columbia, Greenwood, Pendleton and Clemson College. Specimens of this species were often taken in the lantern-trap at Columbia. Active, April 1 to May 20.

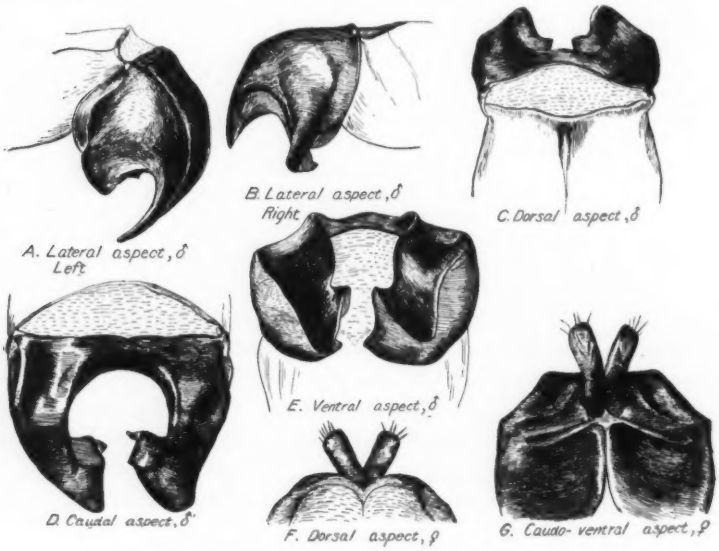
A. Lateral aspect, ♂ Left
B. Lateral aspect, ♂ Right
C. Dorsal aspect, ♂
D. Caudal aspect, ♂
E. Ventral aspect, ♂
F. Dorsal aspect, ♀
G. Caudo-ventral aspect, ♀

FIG. 19. *Phyllophaga anxia* Lec. (Genitalia).
a, Lateral, ♂, Left; *b*, Lateral, ♂, Right; *c*, Dorsal, ♂; *d*, Caudal, ♂; *e*, Ventral ♂; *f*, Dorsal, ♀; g, Caudo-ventral aspect, ♀.

HOST PLANTS—Water Oak (*Quercus nigra* L.)
Black Willow (*Salix* sp. probably *S. nigra* Marsh.)
Common Elder (*Sambucus canadensis* L.)
Farkleberry (*Vaccinium arboreum* Marsh.)
Common Persimmon (*Diospyros virginiana* L.)
Chickasaw Plum (*Prunus angustifolius* Marsh.)
Elm (*Ulmus* sp. probably *alata* Michx.)
Apple (*Pyrus malus* L.)
River Birch (*Betula nigra* L.)
Wild Grape (*Vitis rotundifolia* Michx.)
Sweet Gum (*Liquidamber stryachiflua* L.)
Smooth Alder (*Alnus* sp.)
Wax Myrtle (*Myrica cerifera* L.)
Black Jack Oak (*Quercus marilandica* Muench.)
Sand Blackberry (*Rubus cuneifolius* Pursh.)

15. **Phyllophaga foxii** Davis.

Description: (Davis, 1, p. 334).

Male: Abdomen flattened on the meson; penultimate segment with a sharp oblique ridge on either side, scabrous in between the ridges; ultimate segment decidedly depressed. Inner spur of hind tibia much shorter than the outer one.

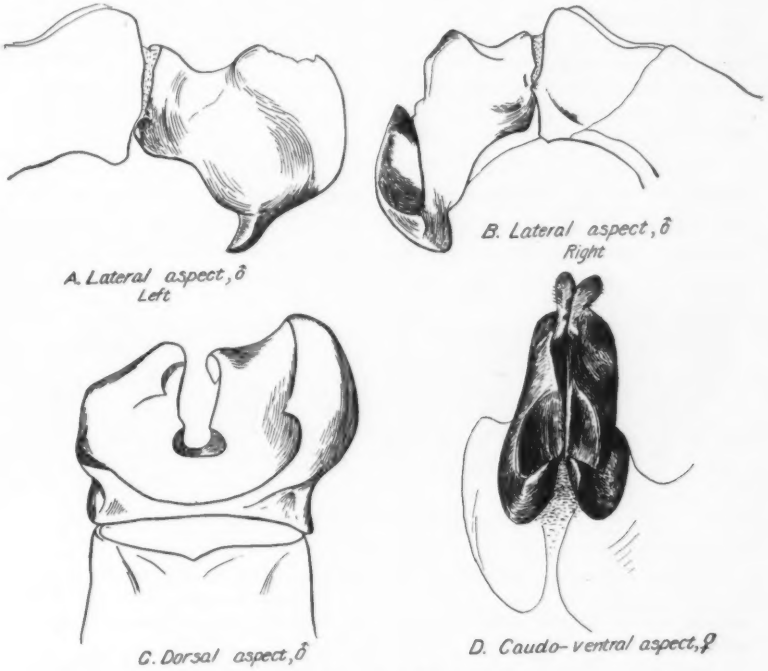

FIG. 20. *Phyllophaga foxii* Davis. (Genitalia).
a, Lateral, ♂, Left; *b*, Lateral, ♂, Right; *c*, Dorsal, ♂; *d*, Caudo-ventral aspect, ♀.

Genitalia (Fig. 20, a to c, inclusive). Telum about 4 mm. long, transversely depressed near the caudal border and also longitudinally on the meson; caudal border straight. Claspers distinctly separated, broad, somewhat spreading. Left clasper shell-like, somewhat rounded on upper caudal margin, sometimes incised on the cephalo-dorsal margin; lower anterior border slightly invaginated, producing a sharp-pointed tip, with another smaller protuberance immediately above the invagination. Right clasper somewhat scoop-shaped from the rear, with the involute area somewhat depressed on its inner face and extend-

ing farther distad than its base, sharp-pointed in the upper corner; caudo-ventrally the clasper flattens out broadly.

Female (Fig. 36, e:). Usually darker than the male.

Genitalia (Fig. 20, d). Genital plates as broad as long, touching on the meson except anteriorly diverging, depressed along the suture line; the distal ends on the meson terminate into blunt protuberances; the sides extend laterad and distad, the outer distal portions forming cup-shaped depressions. Pubic process with a broad proximal portion and a narrow emarginate distal one; the sides of the proximal part straight, becoming much constricted toward the distal end, somewhat relieved before tip is reached, broadening out somewhat and producing a flat tip; proximal portion deeply concave on venter, the depression extending on the constricted portion.

Found throughout the state. Common on the coast, taken sparingly along streams in the interior portion of the state. Collected at Georgetown, White Hall, Columbia and Clemson College. Several specimens were taken in the lantern-trap at Columbia, where the trap was placed near a stream. Active, April 5 to May 10.

HOST PLANTS—Wax Myrtle (*Myrica cerifera* L.)
Water Oak (*Quercus nigra* L.)
River Birch (*Betula nigra* L.)
Common Persimmon (*Diospyros virginiana* L.)
Black Willow (*Salix* sp. probably *nigra* Marsh.)
Sweet Gum (*Liquidamber stryachiflua* L.)
Sand Blackberry (*Rubus cuneifolius* Pursh.)
Hackberry (*Celtis smallii* Beadle).

16. **Phyllophaga forsteri** Burm.

Description: (Smith, 8, p. 509).

Male: Abdomen flattened on the meson; penultimate segment crossed transversely by a curved ridge, which broadens out on the meson; on the lateral sides, the segment is depressed in front of ridge; ultimate segment markedly depressed, smooth.

Genitalia (Fig. 21, a to d, inclusive). Telum 3 mm. long, slightly concave on the upper posterior border. Claspers distinctly separated. Left clasper, with an involute somewhat flattened upper caudal portion, having a circular incision gouged out on the upper caudal border; the size of the cut out area varies greatly in different specimens, sometimes the incision is shallow, at other times very deep; caudo-ventral portion of this clasper is somewhat depressed, pointed. Right clasper scoop-shaped from the rear with tip slightly depressed.

Female (Fig. 36, d).

Genitalia (Fig. 21, e). Genital plates robust, meeting on meson; distal borders undulating; outer posterior portions much thinner, somewhat reclining, with auricle-shaped depressions near borders; in some specimens these ear-like depressions are much reduced. Pubic process composed of a triangular proximal portion and a straight

stem-like distal portion, the latter being about .5 mm. long; the outer lower borders of the proximal portion are rounded and the area in between depressed, this depression sometimes extending part way up the stem; stem slightly notched at the apex.

Throughout the state. Common in the Piedmont section, Georgetown, White Hall, Columbia, Pendleton, Clemson College and Greenwood. Specimens were taken in lantern-trap at Columbia. It was however not a common capture. Active, March 30 to May 25. Maximum abundance April 15 to May 10.

HOST PLANTS—Black Jack Oak (*Quercus marilandica* Muench.)
Georgia Pine (*Pinus palustris* Mill.)
Loblolly Pine (*Pinus taeda* L.)
Common Persimmon (*Diospyros virginiana* L.)
White-heart Hickory (*Carya alba* (L) K. Koch.)
Maple (*Acer* sp.)
Common Elder (*Sambucus canadensis* L.)
River Birch (*Betula nigra* L.)
Smooth Alder (*Alnus rugosa* (Du Roi) Spreng.)
Farkleberry (*Vaccinium arboreum* Marsh.)

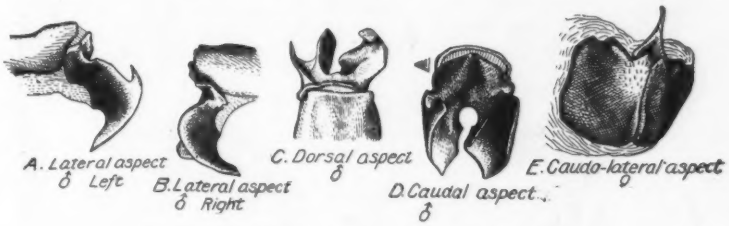

FIG. 21. *Phyllophaga forsteri* Burm. (Genitalia).
a, Lateral, ♂, Left; *b*, Lateral, ♂, Right; *c*, Dorsal, ♂; *d*, Caudal, ♂; *e*, Caudo-lateral aspect, ♀.

17. **Phyllophaga prununculina** Burm.

Description: (Horn, 4, p. 223).

Male: Abdomen somewhat flattened on the meson; penultimate segment with an oblique ridge on either side, the lateral sides bearing long, sparsely placed hairs; ultimate segment depressed with a hairy cusp or protuberance on either side. Club of antenna light yellow. Inner spur of hind tibia wanting.

Genitalia (Fig. 22, a to c, inclusive). Telum about 2 mm. long, posterior portion flattened, the border decidedly concave. Claspers alike, united on the dorsum; anterior portion of the genitalia proper decidedly convex on the dorsum, membranous area circular; rounded posteriorly; caudo-ventral portions incised, producing two points on either side; claspers also extend anteriorly and towards the ventro-meson forming a short outer and long rounded inner tooth on either side; distal opening broadly ovate.

Female: Genitalia (Fig. 22, d and e). Genital plates rounded, converging somewhat posteriorly; line of the suture somewhat depressed; somewhat hairy along the posterior margins. Pubic process composed of a broad plate about 2 mm. wide with two somewhat diverging, thin, broad, stems, producing a deep V-shaped opening on the caudal margin.

Taken at Yonges Island, Stokes, and Columbia. Common at latter place. No specimens from the Upper Piedmont. Specimens of this species were frequently taken in the lantern-trap at Columbia; also one specimen at Yonges Island and several at Stokes. Active, May 31 to July 25. Maximum abundance June 1 to June 15.

HOST PLANT—Loblolly Pine (*Pinus taeda* L.)

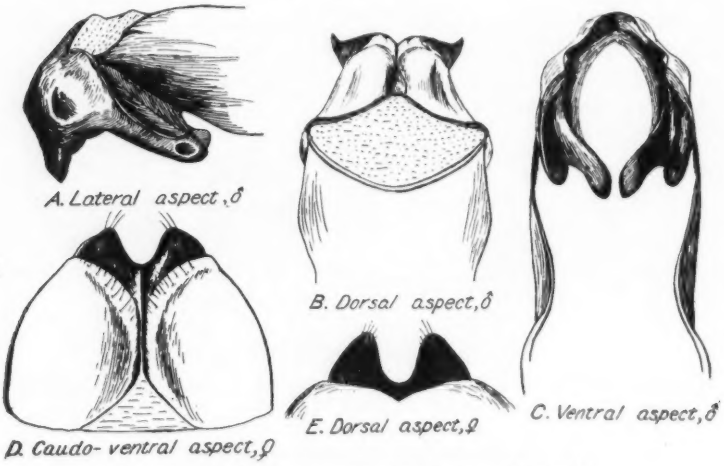

FIG. 22. *Phyllophaga prununculina* Burm. (Genitalia).
a, Lateral, ♂; *b*, Dorsal, ♂; *c*, Ventral, ♂; *d*, Caudo-ventral, ♀; *e*, Dorsal aspect, ♀.

18. **Phyllophaga micans** Knoch.

Description: (Horn, 4, p. 242).

Male (Fig. 36, c). Abdomen flattened on the meson; penultimate segment transversely crossed by a curved ridge; ultimate segment somewhat depressed.

Genitalia (Fig. 23, a to c, inclusive). Telum 4 mm. long, posterior portion shorter and narrower than the anterior one, the former with a depression on the meson. Claspers very much alike, expand 2 mm., about one-half as long, emarginate at the point of union on dorsum, deeply incised on the upper borders, having sharp-pointed protuberances on the upper caudal margins; lower anterior portions of the claspers are

depressed and somewhat toothed; margins along the caudal borders rounded and depressed below the bases of the protuberances; ventral portion of the left clasper is incised while that of the right is entire.

Female: Posterior portion of the penultimate segment on abdomen sometimes depressed.

Genitalia (Fig. 23, d and e). Genital plates thick and about 1½ mm. across; caudo-ventral portion often rounded, producing an offset or ledge; lateral portions extended posteriorly producing groove-like or pocket-like depressions on the sides. Pubic process about .5 mm. long, composed of two short, thick stems usually inserted for their whole length (sometimes slightly exserted) between the posterior portion of the plates, emarginate at apex and bearing a number of setæ at this place.

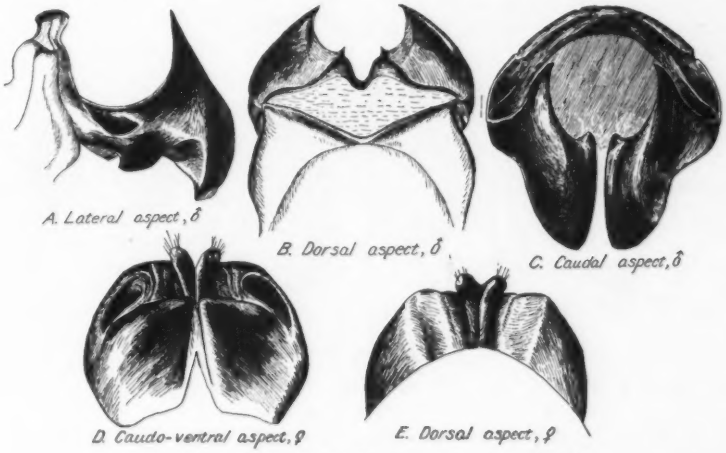

FIG. 23. *Phyllophaga micans* Knoch. (Genitalia).
a, Lateral, ♂; *b*, Dorsal, ♂; *c*, Caudal, ♂; *d*, Caudo-ventral, ♀; *e*, Dorsal aspect, ♀.

Throughout the state but not common. Taken at Georgetown, White Hall, Columbia, Pendleton and Clemson College. Several specimens were taken in the lantern-trap at Columbia. Active, April 10 to May 30. Maximum abundance April 10 to 25.

HOST PLANTS—Common Persimmon (*Diospyros virginiana* L.)
Black Oak (*Quercus velutina* Lam.)
Water Oak (*Quercus nigra* L.)
Black Jack Oak (*Quercus marilandica* Muench.)
Chickasaw Plum (*Prunus angustifolia* Marsh.)
Farkleberry (*Vaccinium arboreum* Marsh.)
Alder (*Alnus* sp. probably *rugosa* (Du Roi) Spreng.)
Maple (*Acer* sp.)

19. **Phyllophaga deanii** new species.

Description: Body ovate, rufotestaceous, head and thorax shining, elytra dull owing to the pruinose coating. Clypeus feebly emarginate, moderately coarsely and closely punctate, its border narrowly reflexed; front with punctures of similar size but not so numerous. Thorax one-half broader than long; surface with punctures of moderate size and abundance; sides arcuately narrowed in front, nearly parallel behind, margins crenate and short ciliate. Elytra with punctures of similar size and abundance as those of the thorax, somewhat rugulose, costæ evident. Pygidium broader than long, slightly pruinose, with a moderate number of fine punctures, more abundant on the sides than on the dorsum. Metasternum closely and finely punctate, hairs abundant and moderately long. Abdomen pruinose, finely and rather closely punctate. Claws arcuate, with a short median tooth. Length 14 to 15 mm.

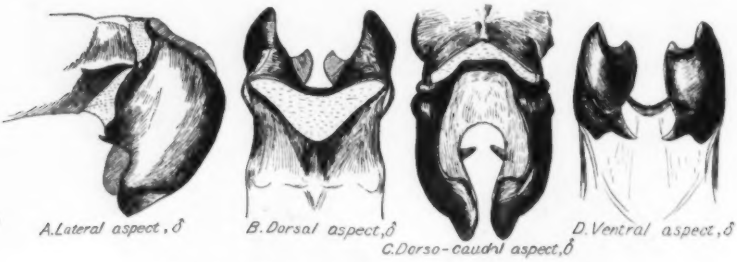

FIG. 24. *Phyllophaga deanii* n. sp. (Genitalia).
a, Lateral, ♂; *b*, Dorsal, ♂; *c*, Dorso-caudal, ♂; *d*, Ventral aspect, ♂.

Male: Abdomen depressed on the meson; penultimate segment crossed transversely by a curved ridge, caudad of which is a deep depression; ultimate segment with a deep somewhat cup-shaped depression, confluent with the depression of the preceding segment. Club of antenna about as long as the stem. Inner spur of hind tibia about half as long as the outer.

Genitalia (Fig. 24, a to d, inclusive). Telum about 5 mm. long, rather narrow, the posterior border deeply incised on the meson. Claspers simple, separate, similar; lateral faces rather broad, their caudo-lateral portions being extended ventrad and somewhat cephalad, forming broad tips on the ventral surface, the tips facing each other; cephalo-ventral portion of each clasper supplied with a short blunt tooth; distal opening somewhat ovate.

Female: Unknown to the writer.

Localities: Collected only at Georgetown.

Active: April 22 to April 28.

HOST PLANT—Water Oak (*Quercus nigra* L.)

Remarks: The type specimen and the paratype specimen were taken from Water Oak (*Quercus nigra* L.) at Georgetown, South Carolina, April 28, 1922, by Mr. Omer Ryan. These specimens have been deposited in the U. S. National Museum.

20. **Phyllophaga impar** Davis.

Description: (Davis, 1, p. 335).

Male: Abdomen slightly flattened on the meson; penultimate segment without any characteristic ornamentation whatever; ultimate segment narrowly tranversely depressed near the posterior border, the depression smooth. Inner spur of hind tibia less than one-half the length of the outer one and fixed.

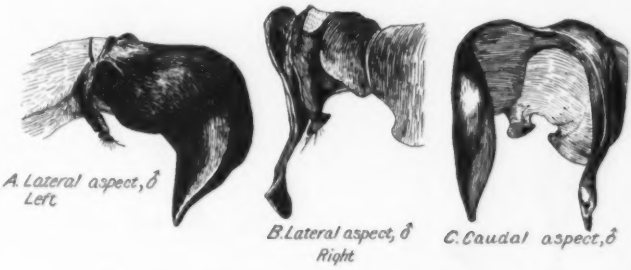

FIG. 25. *Phyllophaga impar* Davis. (Genitalia).
a, Lateral, ♂, Left; *b*, Lateral, ♂, Right; *c*, Caudal, ♂.

Genitalia (Fig. 25, a to c, inclusive). Telum 3 mm. long, posterior border slightly convex. Claspers very dissimilar, united on the dorsum, with deep grooves cephalo-laterad forming a collar to the clasper structure; ventral portions of the collar flatten out and form broad flat tips. Left clasper much the larger, strongly arcuate, the tip pointing cephalad; upper caudal margin somewhat involute; lateral side somewhat rounded. Right clasper much aborted, appearing as if the greater portion of the lateral area were cut off with a sharp instrument, leaving only a very narrow portion in the cephalo-lateral region; tip rounded.

Female: Unknown to the writer.

Taken at Columbia. No specimens from any other part of the state. Period of activity unknown.

HOST PLANTS—Unknown.

21. **Phyllophaga latifrons** LeC.

Description: (Horn, 4, p. 221).

Male: Abdomen channeled on the meson; penultimate segment deeply concave, with another more shallow depression on either side, immediately caudad of which is a slight elevation; ultimate segment at right angles, deeply depressed and bidentate at apex. Inner spur of hind tibia short.

Genitalia (Fig. 26, a to d, inclusive). Telum 3 mm. long, the posterior margin slightly concave; immediately in front of the border there is a slight depression. Claspers alike, united on the dorsum; the cephalic end of the genitalia proper deeply incised, the incision sharp-pointed; membranous area broadly ovate; posterior portions of claspers

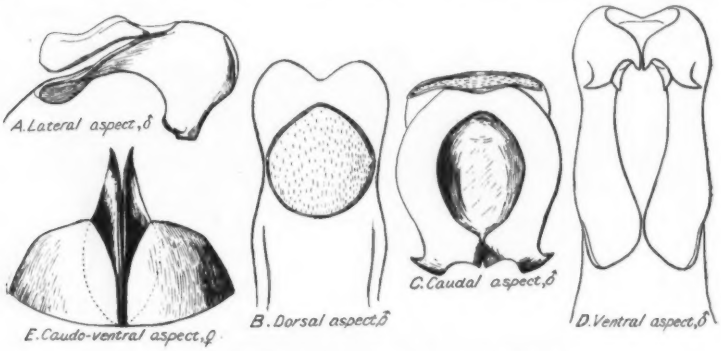

FIG. 26. *Phyllophaga latifrons* LeC. (Genitalia).
a, Lateral, ♂; *b*, Dorsal, ♂; *c*, Caudal, ♂; *d*, Ventral, ♂; *e*, Caudo-ventral aspect, ♀.

extend laterad and caudad, forming rounded caudo-lateral borders, and come together on the meson of the lower caudo-lateral region; claspers are notched on caudo-ventral border; near the meson in the caudal region and laterad of each notch on either clasper is a small tooth-like protuberance; anterior portions of the lobes are extended laterad and cephalad, much depressed laterally, and finally folded over on to the venter, terminating in blunt tips; distal opening circular in outline.

Female: Genitalia (Fig. 26, e). Genital plates broad, about as long as wide, touching only in the cephalic region; posteriorly the plates diverge widely due to the process above. Pubic process about 2 mm. long, somewhat oval in outline, the narrow end distad and attenuate, emarginate at tip, the emargination producing two sharp points which are somewhat reflexed, deeply grooved on the meson; on either side of the groove is a sharp ridge; process sometimes inserted for some distance in between the plates.

A rare species. Taken at Yonges Island, Stokes, and Columbia. Not captured in upper Piedmont section. Majority of specimens collected were taken in lantern-trap at Columbia. One specimen taken in the trap at Yonges Island. Active, June 15 to August 20.

HOST PLANTS—Loblolly Pine (*Pinus taeda* L.)

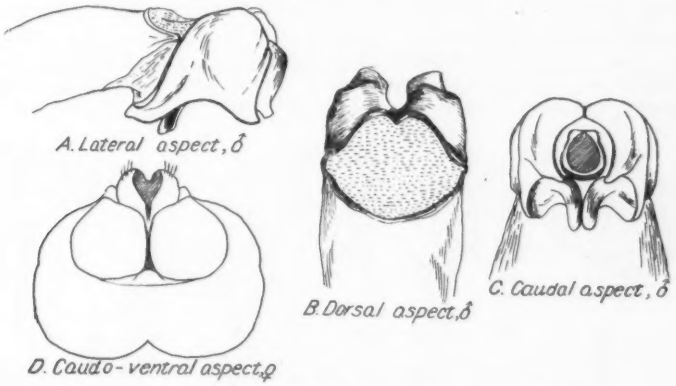

FIG. 27. *Phyllophaga glabberima* Blan. (Genitalia).
a, Lateral, ♂; *b*, Dorsal, ♂; *c*, Caudal, ♂; *d*, Caudo-ventral aspect, ♀.

22. **Phyllophaga glabberima** Blanchard.

Description: (Horn, 4, p. 224).

Male: Abdomen slightly flattened on the meson; penultimate segment scabrous along the posterior border; ultimate segment markedly concave with a short, transverse, conspicuous ridge on each side of the meson within the concavity.

Genitalia (Fig. 27, a to c, inclusive). Telum 3 mm. long, the posterior margin somewhat raised, with a shallow depression along the base of the raised area; posterior end deeply concave, the concavity semi-spherical in outline; membranous area circular in outline; claspers similar, narrowly united on the dorsum, anterior end quite strongly concave; caudal margins sharply defined and bent outward somewhat; claspers rounded laterally, markedly depressed in the lower lateral regions, bent ventrad, producing sharp-pointed tips at the caudal extremities and anteriorly round processes, close together, one on each side of the meson; distal opening large, extending on to the dorsum.

Female (Fig. 27, d). Genital plates 3 mm. across, about as long as broad, plain, somewhat circular in outline, converging on the meson near their distal ends. Pubic process about 1 mm. long, ovate, not wholly exserted; distal end emarginate, producing a somewhat rounded tip on each side of the emargination; also somewhat channeled on the ventro-meson.

Taken at Yonges Island and Stokes. No specimens from any other point in the state. Apparently a coastal species. All specimens of this species in the writer's collection were captured in the lantern-trap. Active, May 5 to June 15.

HOST PLANTS—Unknown.

23. **Phyllophaga ephilida** Say.

Description: (Horn, 4, p. 225).

Male: Abdomen flattened on the meson; penultimate segment transversely crossed near the caudal margin by a sharp ridge, which extends for some distance up the lateral sides and flattens out on the

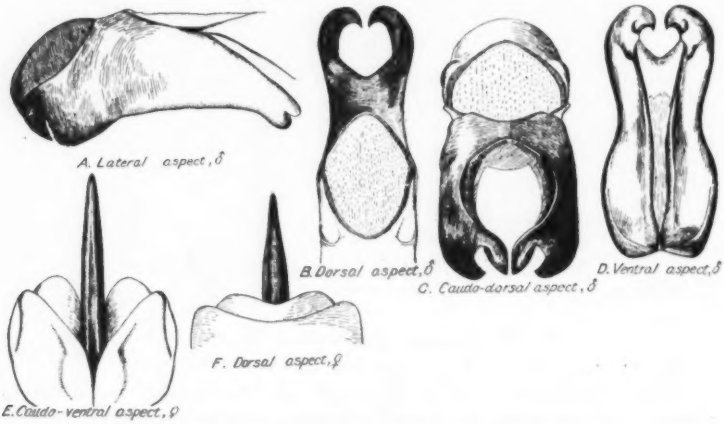

FIG. 28. *Phyllophaga ephilida* Say. (Genitalia).
a, Lateral, ♂; *b*, Dorsal, ♂; *c*, Caudo-dorsal, ♂; *d*, Ventral, ♂; *e*, Caudo-ventral, ♀; *f*, Dorsal aspect, ♀.

meson; ultimate segment much depressed and somewhat emarginate on the caudal border, with a protuberance on each side of the emargination. Inner spur of hind tibia short.

Genitalia (Fig. 28, a to d, inclusive). Telum 2.5 mm. long; anterior portion broad; posterior portion deeply concave on the caudal margin. Claspers alike, united on the dorsum, the anterior portion on the dorsum markedly concave; membranous area elliptical, over 1.5 mm. in diameter; claspers broad and long, extending caudad and mesad, almost touching in the latter region; borders deeply incised; claspers also extend cephalad on venter, ending in round, blunt protuberances, somewhat boot-shaped, markedly depressed cephalad to the protuberances; distal opening oval.

Female: Genitalia (Fig. 28, e and f). Genital plates small, rounded, about 1 mm. long and about half as wide; when the genitalia are extruded these plates separate far apart. Pubic process consists of a stout, horn-like structure about 3 mm. long, slightly grooved on meson and blunt at the apex.

Fairly common at Columbia; also taken at White Hall and Stokes. Not taken in the upper Piedmont. Majority of specimens collected at Columbia were captured in lantern-trap. Several taken in trap at White Hall. Active, June 1 to July 15. Maximum abundance latter part of June.

HOST PLANTS—Birch (*Betula nigra* L.)
Loblolly Pine (*Pinus taeda* L.)

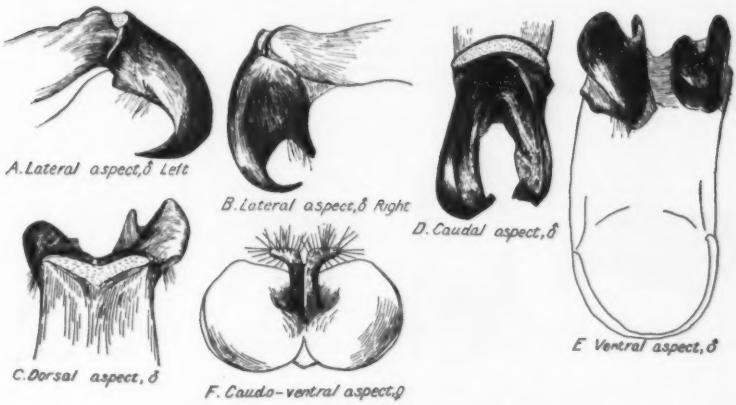

FIG. 29. *Phyllophaga diffinis* Blan. (Genitalia).
a, Lateral, ♂, Left; *b*, Lateral, ♂, Right; *c*, Dorsal, ♂; *d*, Caudal, ♂; *e*, Ventral ♂; *f*, Caudo-ventral aspect, ♀.

24. **Phyllophaga diffinis** Blanchard.

Description: (Horn, 4, p. 243).

Male: Abdomen flattened on the meson; penultimate segment slightly depressed on the sides; ultimate segment slightly depressed on the meson. Inner spur of hind tibia shorter than the outer one.

Genitalia (Fig. 29, a to e, inclusive). Telum about 3 mm. long, slightly concave on the posterior border. Claspers spreading, diverging, narrowly united on the dorsum, the united structure somewhat convex on the cephalic border to fit the concavity in the telum. Left clasper deeply, hemispherically incised on the lower anterior border, the incision producing a claw-like tip which points cephalad. Right clasper similarly incised as the left clasper, except that the incision is somewhat smaller but deeper and the claw-like tip correspondingly longer and

more curved, with another shorter and more blunt protuberance immediately above the incision. A broad ledge extends along caudal face of the claspers, giving them an appearance from the rear as though they had been channeled with a chisel.

Female: Genitalia (Fig. 29, f). Genital plates about 1 mm. long, about as broad, meeting on the ventro-meson; somewhat depressed on the sides; plates extend distad and partly surround the pubic process. Pubic process composed of two stems united in the proximal region with their distal portions bent at right angles; the process might be compared to two riding boots placed back to back and inverted.

Fairly common in upper Piedmont. Taken at Clemson College and Columbia. Not found in lower part of the state. No specimens taken in the lantern-trap. Active, April 10 to May 10. Maximum abundance mid-April.

HOST PLANTS—Red Oak (*Quercus rubra* L.)
White Oak (*Quercus alba* L.)
Black Jack Oak (*Quercus marilandica* Muench.)
Maple (*Acer* sp.)
Common Persimmon (*Diospyros virginiana* L.)

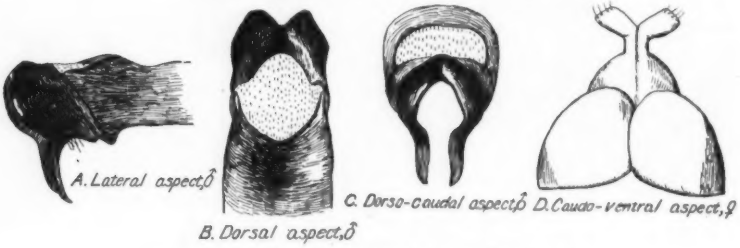

FIG. 30. *Phyllophaga gracilis* Burm. (Genitalia).
a, Lateral, ♂; *b*, Dorsal, ♂; *c*, Dorso-caudal, ♂; *d*, Caudo-ventral, ♀.

25. **Phyllophaga gracilis** Burm.

Description: (Horn, 4, p. 230).

Male: Abdomen slightly flattened on the meson; penultimate segment slightly elevated; ultimate segment slightly depressed.

Genitalia (Fig. 30, a to c, inclusive). Telum 3 mm. long, narrowed posteriorly and convex on the posterior border. Claspers united on the dorsum, the anterior border of the united structure decidedly concave; membranous area somewhat circular in outline; caudal margins of the claspers slope anteriorly and ventrally, finally ending in very long, sharp, somewhat curved hooks about 0.75 mm. in length; anterior portion of each clasper is extended on to the venter, ending in a short blunt tip; distal opening somewhat circular, extending slightly on to the dorsum, making a sharp angle on the meson.

*Female:** Genitalia (Fig. 30, d). Genital plates small. Pubic process composed of a broad, triangular, proximal piece, from the tip of which arise two short, widely diverging stems.

Very rare. Only a few specimens taken at Columbia. Not found in any other point in the state. All the specimens collected were captured in the lantern-trap. Active, June 20 to 26.

HOST PLANTS—Unknown.

26. **Phyllophaga quercus** Knoch.

Description: (Horn, 4, p. 281).

Male: Abdomen yellowish brown, feebly flattened on the meson; penultimate segment depressed, with a protuberance or cusp on each side; the cusp hairy, the depressed area scabrous; ultimate segment depressed.

FIG. 31. *Phyllophaga quercus* Knoch. (Genitalia). *a*, Lateral, ♂; *b*, Caudal, ♂.

Genitalia (Fig. 31, a and b). Telum 2 mm. long, the posterior margin only slightly concave. Claspers united on dorsum, similar, remarkable for their simplicity, with no ornamentation of any kind; long-extended caudo-laterad, ending in blunt rounded points, the tips pointing towards the ventro-meson and almost touching each other; distal opening somewhat ovate.

Female: No specimens of this sex in the writer's collection.

Very rare. Taken at Columbia and Clemson College. No specimens from the southern part of the state. Only one specimen taken in the lantern-trap at Columbia. Active, July 6.

HOST PLANTS—Unknown.

* Specimen collected at Tappahannock, Va., by Dr. Henry Fox. No specimens of this sex collected in this state.

27. **Phyllophaga clypeata** Horn.

Description: (Horn, 4, p. 283).

Male: Abdomen with a channel-like depression on the meson, the depression extending across the meson of the penultimate segment and somewhat scabrous at this point; ultimate segment with a scabrous depressed area, which gradually becomes narrower cephalad. Club of the antenna about as long as the stem. Inner spur of the hind tibia over one-half as long as the outer.

Genitalia (Fig. 32, a to c, inclusive). Telum with the posterior portion bent ventrad, its dorsum flattened and its border very deeply incised; base of incision rounded; membranous area somewhat circular

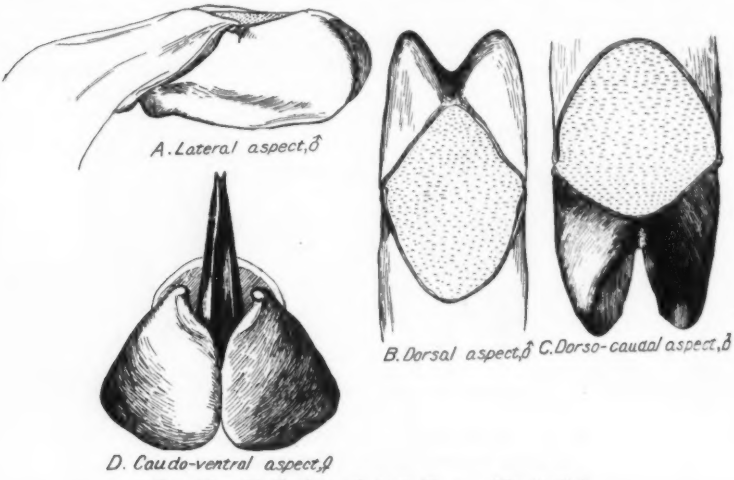

FIG. 32. *Phyllophaga clypeata* Horn. (Genitalia).
a, Lateral, ♂; *b*, Dorsal, ♂; *c*, Dorso-caudal, ♂; *d*, Caudo-ventral aspect, ♀.

in outline. Claspers narrowly united on the dorsum, simple, similar; lateral sides rounded; ventral borders flattened, the caudal rounded; cephalo-lateral portion of each clasper is long-extended cephalad, terminating in a blunt tip on the ventro-meson; distal opening somewhat circular.

Female: Genitalia (Fig. 32, d). Genital plates rounded, without depressions, touching in the middle but diverging distad and forming rounded tips. Pubic process composed of a straight stem tapering to an emarginate apex; considerably depressed on the ventro-meson, especially in the proximal region. Process resembles that in *ephilida*.

Collected only at Stokes. All specimens taken in lantern-trap. Active, July 8.

HOST PLANTS—Unknown.

28. **Phyllophaga lota** new species.

Description: Body oblong-elongate, parallel, cylindrical, rufotestaceous, moderately shining. Clypeus entire, margin rather broadly reflexed, punctures moderate in size, closely placed; front similarly punctate. Thorax two-thirds broader than long; surface moderately punctate, the punctures not quite as close as those of the head; sides arcuately narrowed in front, nearly parallel behind, margins entire. Elytra moderately punctate, punctures rather close, costæ evident. Pygidium convex, shining, sparsely and finely punctate. Metasternum moderately coarsely and closely punctate, hairs moderate in length and sparse. Abdomen shining, with moderate number of fine punctures. Claws arcuate, median tooth obsolete. Length 12.3 mm.

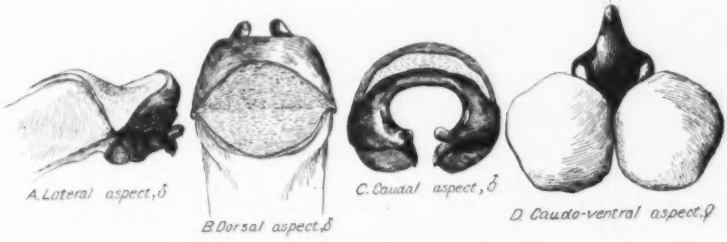

FIG. 33. *Phyllophaga lota* n. sp. (Genitalia).
a, Lateral, ♂; *b*, Dorsal, ♂; *c*, Caudal, ♂; *d*, Caudo-ventral aspect, ♀.

Male: Abdomen depressed on the meson; penultimate segment with a small elevated area near the posterior border, cephalad of which on each side and extending obliquely laterad for a short distance is a shallow groove; ultimate segment with a narrow transverse depression. Club of the antenna as long as the stem, whitish. Inner spur of the hind tibia about half as long as the outer.

Genitalia (Fig. 33, a to c, inclusive). Telum with a depression on each side of the meson in the posterior region; posterior border narrowly convex. Claspers narrowly united on the dorsum, in the caudo-mesal region; cephalo-mesal region deeply convex; lateral sides rounded; lower caudal portions extended into short protuberances which point in a mesal direction and are forked at their apices; distal opening oblong-oval in outline.

Female: Genitalia (Fig. 33, d). Genital plates 2 mm. wide, touching on the meson, the distal ends obtuse. Pubic process about 1 mm. long, composed of a broad proximal portion and a much narrower distal portion; proximal portion rounded on sides with a depression in the middle; distal portion tapering toward apex.

Collected only at Stokes. All specimens taken in the lantern-trap. Active, June 10 to July 8.

HOST PLANTS—Unknown.

Remarks: The specimen, a male, selected as the type was captured in the lantern-trap at Stokes, South Carolina, July 3, 1923, by Miss Lota Bootle. A paratype was taken at the same place and in the lantern-trap on July 8, 1924, by Miss Bootle. Both specimens have been deposited in the U. S. National Museum.

29. **Phyllophaga dispar** Burm.

Description: (Horn, 4, p. 284).

Male: Abdomen slightly flattened with a shallow channel on the meson; penultimate segment slightly depressed on each side; ultimate

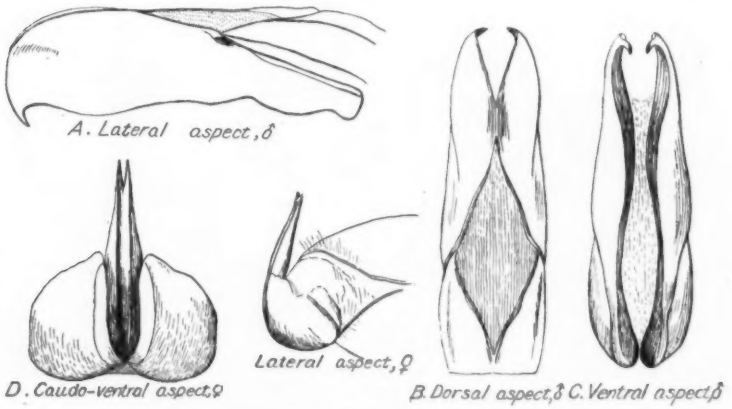

FIG. 34. *Phyllophaga dispar* Burm. (Genitalia).
a, Lateral, ♂; *b*, Dorsal, ♂; *c*, Ventral, ♂; *d*, Caudo-ventral, ♀; *e*, Lateral aspect, ♀.

segment depressed, with two tooth-like protuberances arising from near the caudad border and pointing caudad, margin on each side of the protuberance somewhat advanced.

Genitalia (Fig. 34, a to c, inclusive). Telum somewhat longer than broad, with a deep somewhat V-shaped incision on the caudal border. Claspers similar, united on the dorsum, the united structure deeply convex on the cephalo-mesal region; membranous area somewhat diamond-shaped; claspers extend laterad on the lower caudal margin and form sharp-pointed hooks, which point in a cephalo-mesal direction; a portion of the lower margin of each clasper is inrolled; anteriorly the claspers are long-extended, ending in somewhat protruding tips, depressed near the borders; length along the ventro-mesal region 3 mm.; distal opening extends part way on to the dorsum.

Female: Genitalia (Fig. 34, d and e). Genital plates over 1 mm. broad and about as long, touching on the meson, but diverging widely

anteriorly and posteriorly; suture on meson distinct. Pubic process composed of a long curved stem about 2 mm. long and twice as broad at the proximal as at the distal end; stem is curved dorsally, bent dorsad, deeply grooved on the meson of the caudal region, bidentate at tip.

Not common. Taken at Columbia and at Stokes. Majority of the specimens captured in the lantern-trap. Active, June 15 to July 10.

HOST PLANTS—Loblolly Pine (*Pinus taeda* L.)

30. **Phyllophaga villifrons** LeC.

Description: (Horn, 4, p. 263).

Male: Unknown to the writer.

Female: Genitalia (Fig. 18, b). Genital plates 3.5 mm. across, about 2 mm. long, with a very deep depression across the meson of the posterior portion, producing a ledge in front; immediately posterior to the depression the pubic process originates. Pubic process about 0.5 mm. long, composed of a short, broad, flat proximal portion and the two short, flat, broad diverging stems; process has the appearance of a squatty Y.

Taken only at Clemson College. No specimens taken in the lantern-trap. Active, April 26.

HOST PLANTS—Oak (*Quercus* sp.).

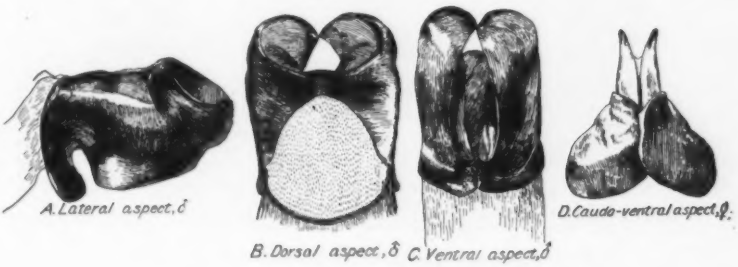

FIG. 35. *Phyllophaga soror* Davis. (Genitalia).
a, Lateral, ♂; *b*, Dorsal, ♂; *c*, Ventral, ♂; *d*, Caudo-ventral aspect, ♀.

31. **Phyllophaga soror** Davis.

Description: (Davis, 1, p. 333).

Male: Abdomen flattened on the meson; penultimate segment scabrous with the sides somewhat wrinkled; ultimate segment with a cup-shaped concavity and a conspicuous ridge on each side, the ridges transversely depressed in the middle. Inner spur of hind tibia free, less than one-half the length of the outer.

Genitalia (Fig. 35, a to c, inclusive). Telum 3 mm. long, decidedly concave on the posterior end. Claspers similar, narrowly united on the dorsum, the cephalic portion deeply incised; membranous area somewhat oblong-oval in outline; claspers long, conspicuously rounded on the sides, the caudo-lateral margins involute, forming a heart-shaped distal opening; anterior portions on the venter are deeply depressed, forming broadly rounded tips, cephalad to the depression.

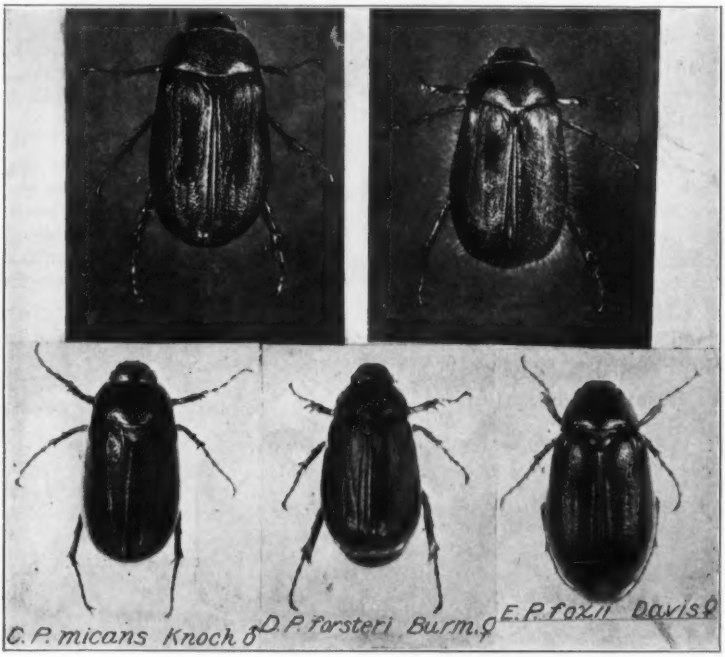

FIG. 36. Adults.

a, P. anxia LeC., ♀; *b, P. hirsuta* Knoch, ♀; *c, P. micans* Knoch., ♂; *d, P. forsteri* Burm., ♀; *e, P. foxii* Davis, ♀.

Female: Genitalia (Fig. 35, d). Genital plates about 2 mm. across, about as long as wide, touching for the greater distance on the meson, wide at their distal points where they diverge widely and form sharp angles. Pubic process composed of a thin plate, somewhat lyrate in outline, about 1 mm. long and over one-half as wide at its widest point, deeply incised in the distal region, the incision V-shaped and producing a bidentate tip; process somewhat depressed on meson.

Taken at Columbia. No specimens from any other point in the state. Two specimens taken in the lantern-trap at Columbia. Active, June 26 to July 1.

HOST PLANTS—Unknown.

HOST PLANTS OF PHYLLOPHAGA SPECIES

1. White-heart Hickory (*Carya alba* (L) K. Koch).
2. Common Persimmon (*Diospyros virginiana* L.)
3. River Birch (*Betula nigra* L.)
4. Black Jack Oak (*Quercus marilandica* Muench.)
5. Elm (*Ulmus* sp. probably *alata* Michx.)
6. Oak (*Quercus* sp.)
7. White Ash (*Fraxinus americana* L.)
8. Red Oak (*Quercus rubra* L.)
9. Black Scrub Oak (*Quercus ilicifolia* Weng.)
10. White Oak (*Quercus alba* L.)
11. Black Oak (*Quercus velutina* Lam.)
12. Water Oak (*Quercus nigra* L.)
13. Common Elder (*Sambucus canadensis* L.)
14. River Birch (*Betula nigra* L.)
15. Haw (*Crataegus* sp. probably *C. tomentosa* L.)
16. Loblolly Pine (*Pinus taeda* L.)
17. Choke Cherry (*Prunus virginiana* L.)
18. Wild Grape (*Vitis* sp. probably *V. rotundifolia* Michx.
19. Wild Rose (*Rosa* sp.)
20. Hackberry (*Celtis smallii* Beadle)
21. Black Walnut (*Juglans nigra* L.)
22. Green Briar (*Smilax* sp.)
23. Sand Blackberry (*Rubus cuneifolius* Pursh.)
24. Maple (*Acer* sp.)
25. Sumac (*Rhus* sp. probably *R. copallina* L.)
26. Apple (*Pyrus malus* L.)
27. Chickasaw Plum (*Prunus angustifolia* Marsh.)
28. Farkleberry (*Vaccinium arboreum* Marsh.)
29. Flowering Dogwood (*Cornus florida* L.)
30. Sweet Gum (*Liquidamber strychiflua* L.)
31. Georgia Pine (*Pinus palustris* Mill.)
32. Black Willow (*Salix* sp. probably *S. nigra* Marsh.)
33. Wax Myrtle (*Myrica cerifera* L.)
34. Smooth Alder (*Alnus rugosa* (Du Roi) Spreng.)

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THE LARVAL WAX GLANDS OF THE DOGWOOD SAWFLY (MACREMPHYTUS VARIANUS NORTON).*

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Introduction.

Waxy secretions have been observed on the larvæ of various species of sawflies (Tenthredinidæ) especially in the subfamilies Diprioninæ, Emphytinæ, Selandriinæ, Tenthredininæ and Nematinæ. In some cases the secretion was scanty, being evident as a waxy bloom on the surface of the cuticula. In others it was considerable, forming flocculent masses which concealed the entire body of the larva. Packard (1898)† described and figured the larva of a Selandria whose body was nearly concealed by long thread-like masses of wax. So far as could be ascertained no description of the wax glands of any species of sawfly has appeared in entomological literature. Consequently a discussion of the structure of these glands in the larva of *Macremphytus varianus Norton* will not be out of place at this time.

The Wax Secretion.

Throughout the greater part of the larval stage of this species, the dorsal aspect of the head and the dorsal and lateral aspects of the body are covered with a white waxy secretion. It is not present during the first larval instar. It appears in the second instar several hours after the first molt, and is present in each succeeding instar until the prepupa stage when it disappears. It is formed anew after each molt. It rubs off quite easily, but is soon renewed. Its appearance varies somewhat in the different instars. During the second and third stages it presents a white wooly appearance. In the subsequent instars, with the exception of the prepupal stage, definite areas on the dorsal and lateral aspects of each annulet exude waxy threads measuring about 1 mm. in length. These break up and spread over the remainder of the annulets, even to the

* Contribution from the Department of Zoology and Entomology, Pennsylvania State College.

† Packard, A. S., 1898. Text-book of Entomology, p. 365.

dorsal aspect of the head. No secretion is formed on the pigmented area on the dorsal aspect of the epiproct. This pigmented area is quite noticeable when the larva is coiled up helix-like, for while in this position the epiproct forms the apex of the coil, and the black spot simulates the appearance of an eye against the white background.

Technique

For studying the pores through which the wax exudes to the exterior, small larvæ were punctured with a fine dissecting needle, and boiled in a ten per cent solution of caustic potash until the internal organs were dissolved. Larger larvæ were cut in halves longitudinally, and were treated in a similar manner. In both cases the remaining cuticula was stained with acid fuchsin or iron haematoxylin, washed, and mounted in glycerine jelly, or dehydrated, cleared, and mounted in balsam. The iron haematoxylin proved to be the better stain.

For histological study, larvæ were fixed in Fleming's (strong), Zenker's Dietrich's and Bouin's fluids. All of these fixing agents gave satisfactory results. Some larvæ were imbedded in paraffine, but in most cases, the combined paraffine and celloidin method of Apathy was used. While this method requires a much longer time and makes subsequent staining a little more difficult, yet the writer is convinced that it is the best imbedding method for insect tissues, as shrinkage is reduced to a minimum, the injurious effects of prolonged exposure to heat required by the paraffine method is eliminated, and thin sections can be cut without difficulty. Care must be taken, however, to maintain the proper tilt to the microtome knife in cutting material imbedded in this way, else wavy sections are liable to result.

Cross and longitudinal sections of the entire larva of each instar were cut from 6 to 18 micra in thickness. These were attached to slides by the Mayer Albumen-and-water method, and after drying, were stained with Heidenhain's iron haematoxylin, and Delafield's haematoxylin with eosin as a counterstain. Good results were obtained with both stains.

The Cuticula of the Wax-producing Areas.

A study of the surface of the cuticula of the various larval stages in the wax-producing areas brought out some interesting

points. In newly-hatched larvæ the convex cuticula on the tergal annulets of both thorax and abdomen showed more or less regular star-shaped elevations, with central basin-shaped depressions. These elevations, inconspicuous at first, became more pronounced towards the close of the instar, and projected rather conspicuously above the general cuticular surface. They are confined entirely to the tergal annulets, and are not found on the epipleurites, hypopleurites, spiracular areas, nor ventral surface.

In subsequent instars, these elevations are found in groups on the dorsal and lateral aspects of each tergal annulet on both thorax and abdomen. They are absent on the dorsal aspect of the epiproct. They resemble miniature volcanoes, projecting from the cuticular surface, with apical shallow cupshaped depressions. The margins of these cup-shaped depressions have become rounded and show faintly crenated edges. They are also more heavily chitinized. These elevations are conspicuous from the second to the sixth instar inclusive. In the seventh and eight instars they are much less prominent, while during the prepupal stage they are entirely absent. In order to determine the relation of these projections to the underlying hypodermal cells, pieces of the body wall were stained in Delafield's haematoxylin, cleared, and mounted in balsam. A study of these showed that each projection with its crater-like depression, was situated over an underlying hypodermal cell. In no instance were they found in any other position. Furthermore, numerous very fine pores were found in the crater-like depressions, indicating that these projections with their cup-shaped craters were the outlets of the waxy secretion. From the second instar until the prepupal stage, the surface of the cuticula except on the ventral aspect, the pigmented area on the epiproct, and those areas where the projections are present, is covered with minute sharp spines which probably function in anchoring the waxy secretion.

Structure and Development of the Wax Glands.

A study of both longitudinal and cross-sections of larvæ in the various instars was next made. The hypodermis of the newly emerged larva is rather thin and flat, and of uniform thickness on the dorsal, lateral, and ventral surfaces. The

cytoplasm appears quite homogeneous. The nuclei are rather elongate-oval, with relatively few densely-staining chromatin granules. They are almost as thick as the hypodermis itself, and in many cases cause the surrounding hypodermis to bulge. There are no apparent divisions between the individual cells, the entire hypodermis presenting the appearance of a synctium. During the latter part of the first instar, however, the hypodermis underlying the cuticular projections increases in thickness, and the nuclei become distinctly rounded. This would seem to indicate that the hypodermis was in the process of becoming modified for secreting the waxy covering. No change was apparent in the hypodermis in other parts of the body.

During the second instar there is no apparent increase in the thickness of the glandular hypodermis, but the cytoplasm has become more granular. From the third to the eighth instar inclusive, there is a gradual thickening of the modified hypodermis in each successive instar in those regions underlying the cuticular projections. The cells possess large vesicular nuclei, with relatively thick nuclear walls, and contain deeply-stained chromatin granules. The cytoplasm is granular in appearance, and contains vacuoles which probably represent accumulations of the secretion on their way to the exterior. The cells of the non-secreting hypodermis, on the other hand, remain flattened, with their long axes parallel to the surface of the underlying cuticula, with finely granular cytoplasm, and elongate flatted nuclei containing chromatin granules.

From the foregoing observations, therefore, it will be seen that the hypodermal cells underlying the cuticular projections have become specialized, their entire structure indicating that they have become secretory in nature. Their secretion passes through very minute canals which open to the exterior in the cup-shaped depressions in the overlying cuticular projections. These canals are evident only in sections cut exactly perpendicular to the surface of the cuticula. Otherwise it is impossible to distinguish them. In favorable sections they show as fine streaking of the cuticula. The waxy secretion issues in the form of fine threads, and soon breaks up into fine particles which cover the dorsal aspect of the head, and the dorsal and lateral aspects of the thorax and abdomen, being held in place by the minute spines which cover the non-secreting areas.

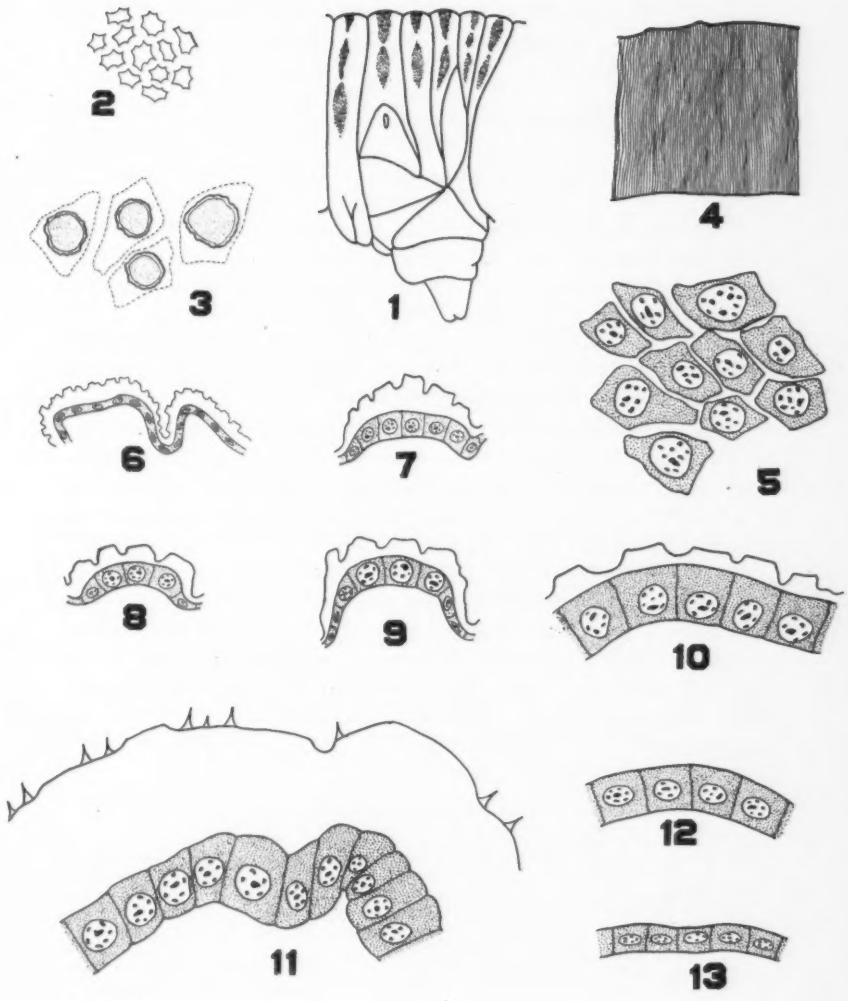
The waxy secretion disappears at the time of transformation to the prepupal stage. A study of sections of this stage made immediately after transformation, shows that the wax-secreting cells of the previous instars have become considerably flattened, undoubtedly due to the cessation of their secretory function. Similar observations on the cells in the same areas in prepupæ which had hibernated in pieces of wood, showed that the cells had returned to the condition characteristic of the hypodermis in other parts of the body.

Function of the Wax.

This waxy secretion may be of use to the larvæ in camouflaging them from some enemies. Individual larvæ from a distance look like bird droppings or bits of white wool. In masses they appear as white patches on the foliage. Once an enemy would learn to recognize them however, the secretion would tend to make them more easily detected.

EXPLANATION OF PLATE V.

Fig. 1. Third abdominal segment of larva, lateral aspect. Stippled parts represent wax-secreting areas.
Fig. 2. Cuticular markings on newly hatched larva. Stellate areas represent the margins of slight cuticular elevations.
Fig. 3. Position of the apices of the cuticular projections with reference to the underlying wax-secreting cells.
Fig. 4. Section of cuticula showing pores to exterior.
Fig. 5. Surface view of the wax-secreting cells.
Fig. 6. Longitudinal section through body wall of a newly hatched larva in an area which secretes wax in subsequent instars.
Fig. 7. Longitudinal section of body through an annulet of the first instar larva just before the first molt, in a wax-secreting area of subsequent instars.
Fig. 8. Longitudinal section of body wall through a wax-secreting annulet of the second instar larva, just after the first molt.
Fig. 9. Longitudinal section of the body wall through a wax-secreting annulet of the second instar larva, just before the second molt.
Fig. 10. Longitudinal section of the body wall through a wax-secreting annulet of the sixth instar larva.
Fig. 11. Longitudinal section of the body wall through a wax-secreting annulet of the eighth instar larva.
Fig. 12. Hypodermis of prepupa in late summer immediately after transformation to that stage, in a wax-secreting area of previous instars.
Fig. 13. Hypodermis of prepupa in the spring just before pupation, in a wax-secreting area of previous instars.



E. B. Dusham

A KEY TO THE FORMS OF THE GENUS CHLOSYNE.
(Lepidoptera, Nymphalidæ).

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Chlosyne, better known by the preoccupied name of Synchloe, is one of the characteristically Neotropical genera, in which the number of well marked species is relatively small, while the number of well marked varieties and races which have received names is very large. It is not possible with the limited material available to bring complete order out of the chaos, but the following key may be of some use as a guide to identification, and suggestive as to the specific or varietal status of the better characterized forms.

The genus itself is none too well defined, being an immediate derivative of Melitæa, with which it seems to intergrade. It is entirely possible that the boundary might better be drawn at a different place, either removing the *endeis* group to one of the subgenera of Melitæa, or adding some of the western U. S. and Mexican Melitæas to this genus.

The key is based primarily on the material in the collection of Cornell University, supplemented by a careful study of the collections of the Carnegie Museum at Pittsburgh, the U. S. National Museum, and the American Museum of Natural History at New York. The asterisk (*) indicates species at Ithaca, while the dagger (†) marks those studied in other American collections.

KEY TO FORMS.

A. Wings long, especially in male.
  B. Under side of hind wing with red inner subterminal spots, the last one round, and above the fold, followed by a marginal whitish line (usually double) which forms lunules between the veins; upper side tawny (*perezi*)
    C. A double series of tawny subterminal spots on forewing, the outer series suffusing in with the general tawny margin below. Basal three-fifths yellow and tawny, (Puerto Rico)..... **†p. tulita**
    CC. A single series of tawny spots, above and below, corresponding to the inner series of tulita. Basal three-fifths pale yellow, (Jamaica), **†p. seitzi**
    CCC. A single series of small white spots above, the second series visible below as small white lunules. Base black with small pale spots, (Cuba)..... **†p. perezi**

BB. Subterminal spots below white or yellow, and both series made up of well separated spots.
C. Upper side yellow or yellow and orange (*narva*).
D. Light portions of upper side wholly yellow; fascia across cell of hind wing strong, (Venezuela).....†**n. narva**
DD. Light portions of upper side heavily shaded with orange; fascia weak or broken, (C. R. to Ecuador).....***n. bonpland** (*brunhilda*)
E. Ground of under side of hind wing clear yellow.....†*typical*
EE. Under side of hind wing shaded and suffused with brown..ab. **judith**
CC. Upper side of fore wing marked with red, of hind wing with yellow, (*gaudialis*).
D. Tawny red area of fore wing practically confined to cell and a dot in cubital cell, (Guatemala).....†**g. gaudialis**
DD. Tawny area extending half its length beyond cell, and filling most of basal third of cell Cu_2 as well as base of Cu_1, (Nicaragua to Pan.), †**g. laeta**

AA. Wings normal in form.
B. A red anal spot, at least on under side.
C. Spot round, rarely squarish, and wholly above 2d A, preceded by other red spots on under side; the red band when present nearer the margin than the cell, and marginal in cell Cu_2.
D. A yellow post-medial fascia on hind wing at least, with at most a small yellow dot in the cell, (*marina*)[1]
E. Hind wing with four or five post-medial red spots only, if four, with a yellow or obsolescent one between the first two and last two.
F. Fore wing beneath with considerable orange on basal half, above normally with a large yellow spot in end of cell..†**m. marina**
FF. Fore wing beneath with an orange costal streak only, above with very little yellow in cell.
G. Postmedian spot in cell M_3 small and pale, contrasting, **m. hylaeus**
GG. Postmedian spot in cell M_3 red like the others, **erodyle eumeda** (*dryope, fasciata*)
EE. Hind wing beneath with considerable orange in basal and medial regions.....**m. endeis**
DD. Hind wing with a large yellow patch, filling outer part of cell, usually two-thirds; spot in cell M_3 of hind wing below either absent, or small and yellow or white, contrasting with the others, (*erodyle*).
E. Under side mostly black at base, with a broad solid black fascia over base of Sc and across cell; dot in cell obsolescent; post-medial black dots continuous with next fascia in part.
F. Fore wing with white dots.....†**e. erodyle**
FF. Fore wing with (usually larger) yellow dots, †**e. pœcile** (*rubriguttea*)
EE. Under side with very little black, the antemedial fascia broken into a slender sub-basal one, dots in cells Sc, R, Cu, and streaks below, also postmedial black series widely separated from black edging of the red fascia, but with a large black spot in cell, (Mex.), †**melitæoides**
DDD. Hind wing all black; fore wing with a yellow fascia of spot across apex to anal angle.....†**melanarge**
CC. Spot more or less triangular and bisected by the fold, often resting on inner margin or continued in a reddish median fascia; red band somewhat nearer cell than border, in cell Cu_2 resting on *middle* of vein Cu_2, (*lacinia*)[2]

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[1] I have not seen sufficient material of this group and may have misinterpreted some of the briefer descriptions.

[2] There is every possible intergrade between the various forms of lacinia.

D. Both wings with a broad tawny median area, sometimes shortly interrupted on fore wing.
E. Costa and cell of fore wing beneath mainly tawny..*l. **californica**
EE. Costa and cell beneath toward base mainly black, marked with yellow, and at most shaded with tawny.
F. Hind wing with orange area above extending to base; subterminal series of spots faint or yellow.....*l. **saundersi**
FF. Hind wing with a broad median area and one or two large orange spots in the cell; subterminal spots tawny.....†l. **fassli**
FFF. Intermediate between *fassli* and *adjutrix*.....†l. **felderi**
FFFF. Hind wing with only median third orange, basal third black with at most a small tawny spot....*l. **adjutrix** (*lacinia* auct.)
DD. Both wings above with a conspicuous but narrow pale band or series of spots.
E. Spots pale yellow or white.....*l. **crocale**
EE. Spots light tawny....*l. **rufescens** (intergrades with *nigrescens*)
DDD. Hind wing with a red patch, contrasting with the pale yellow or white on fore wing.
E. Patch broad, fore wing with small spots,...†l. **lacinia** (*mediatrix*)
EE. Patch reduced to a band of several separate spots; fore wing typically with small spots, as an aberration with a broken band, (Röber).....†l. **tellias**
DDDD. Hind wing with at most a dull and suffused pale median band.
E. Fore wing with markings rufous, though reduced.....l. **pretona**
EE. Fore wing with markings yellow with some tawny, much reduced, l. **paupera**
EEE. Fore wing with markings white.
F. Fore wing with separate spots, sometimes tending to run into band from costa to inner margin.....*l. **nigrescens**[3]
FF. Fore wing with a nearly continuous band from costa to middle of outer margin.
G. Under side of hind wing with median area solid black, †l. **adelina**
GG. Under side of hind wing with a partial medial yellow band, †l. **quehtala** (*misera*)
DDDDD. Fore and hind wings both with similar large tawny patches toward inner margin, the fore wing typically also with a costal patch nearly meeting the dorsal one.....l. **ardema**
BB. Hind wing with a red median fascia below, crossing Cu_2 at two-thirds way to margin, and not approaching anal angle.
C. Hind wing above with a red discal patch, contrasting with the markings of fore wing.....*__janais__ (Mex.)
CC. Hind wing above at most with a few postmedial white dots, (*hyperia*).
D. Hind wing with fringe spots confined to fringe; a few postmedial white spots.....†__marianna__ (*adelina* of Seitz)
DDD. Hind wing solid black with conspicuous and enlarged fringe-spots, rarely in transitional specimens showing the postmedial spots of the other forms; fore wing with a more distinct *transverse* series of spots.....†__hyperia__ (*hippodrome*)
BBB. Hind wing with at most three well marked tawny spots, in cells (M_3), Cu_1 and Cu_2, the latter slightly beyond middle; base toward costa and across cell black, with sub-basal and narrow antemedial oblique yellow bars, sometimes broken into spots or much reduced, more oblique than in *lacinia* forms; upper side with *lacinia* pattern, but outer margin of fore wing more notched, spots in cells R_5 and M_1 slightly offset and both large; hind wings with only a slight orange tint, (Mex.).....†__rosita__

OMITTED: *fruhstorferi* (description inadequate and no material seen); *irrubescens* Hall.

[3] Specimens from Mexico have a yellow band beneath, those from Costa Rica are without.

STUDIES ON THE CRANE-FLIES OF MEXICO.

PART IV.*

(Order Diptera, Superfamily Tipuloidea).

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In the present paper, I wish to discuss additional species of crane-flies that were taken in various parts of Mexico by Dr. Alfons Dampf, Government Entomologist. A very considerable proportion of the species were taken in the State of Chiapas, under conditions that have been discussed in general terms in the preceding part under this same title (Annals Ent. Soc. America, 20:301-318; 1927). A few additional localities require special explanation:

Nayarit: Near Tepic, Nayarit, altitude 945 meters, swept from shrubs and bushes on shores of swift-flowing rivulet, March, 1927. M. B. 203. *Geranomyia* (*Geranomyia*) *perfecta* sp. n.

Rio Mayo: Near Navojoa, Sonora, March, 1927. M. F. 1221. *Cryptolabis* (*Cryptolabis*) *fuscovenosa* sp. n.

Desierto de los Leones: Near Mexico City, altitude 3,100 meters, in *Abies* forest, swept from along a swift-flowing aqueduct, March, 1925. M. B. 116. *Shannonomyia moctezuma* sp. n. This locality has been discussed in greater detail in an earlier part of this series of papers (Annals Ent. Soc. America, 18:341-362; 1925).

In this paper, and others prepared subsequently to 1926, I have adopted the interpretation of the radial field of the wing that has been discussed in detail in other papers (Proc. Linn. Soc. New South Wales, 52:42-72, 92 figs.; 1927; Rec. Indian Museum, 29:167-214, plate; 1927). Several Australasian Entomologists, especially Drs. Mackerras, Tillyard and Tonnoir, have considered that the interpretation as given was too conservative in that it was not applied to all of the subfamilies and tribes of the family. I now consider that this emendation is advisable and by applying the following changes to the

* Contribution from the Entomological Laboratory of the Massachusetts Agricultural College.

Tipulinæ, Cylindrotominæ, and the tribes Limoniini and Lechriini, all groups within the family are brought into harmony:

First section of $R_1 = Sc_{2+}R_1$.
Distal section of $R_1 = Sc_2$ (free tip).
$r = R_1$.
$R_2 = R_{1+2}$.

As before, I wish to express my deepest thanks to Dr. Dampf for the privilege of studying these extensive series of Tipulidæ and of retaining the types of the novelties herein described.

Tipula Linnaeus.

Tipula zeltale sp. n.

Belongs to the *moctezumæ* group; antennæ (♂) of moderate length, 13-segmented, bicolorous; wings strongly tinged with brown, variegated with conspicuous whitish spots.

Male. Length, about 16 mm.; wing, 19-20 mm.

Female. Length, about 26-31 mm.; wing, 19-22 mm.

Frontal prolongation of head relatively long, dark chestnut-brown laterally, the dorsum dusted with yellow; nasus long and slender; palpi black. Antennæ (♂) of moderate length, if bent backward extending about to the base of the abdomen; scape and first flagellar segment yellow; remaining flagellar segments bicolorous, the basal enlargement black, the remainder of the segment yellow, on the outer segments the coloration passing through brownish yellow to brown; first flagellar segment of moderate length only, subequal to the first scapal; remaining flagellar segments increasing in length and decreasing in diameter outwardly; terminal segment very small, elongate-conical; antennæ (♀) shorter and the bicolorous nature poorly indicated. Front yellow, the vertex dark brown, the posterior orbits more yellowish.

Pronotum brown. Mesonotal praescutum dark brown, the usual four brown stripes entire and but little different in color from the interspaces, the whole surface dusted with a sparse pollen, the lateral margins more broadly so, the humeral region darker brown; in the paratype female the stripes are very distinct, brownish black, the interspaces golden-yellow; scutum dark brown, the posterior portions more pruinose; scutellum and postnotum dark, gray pruinose, with a capillary brown median vitta. Pleura dark, indistinctly variegated with paler, the surface dusted with brown and gray; dorso-pleural membrane buffy brown. Halteres long, yellow, the knobs infuscated. Legs with the coxæ dark, pruinose; trochanters obscure brownish yellow; remainder of legs very long and slender, the femora brownish yellow, brighter basally, the tips narrowly but conspicuously blackened; tibiæ yellowish brown, the tips even more narrowly dark brown; tarsi dark brown; basitarsi longer than the tibiæ. Wings strongly tinged with brown, the base and costal region more yellowish brown; stigma rather ill-delimited, pale brown; conspicuous whitish areas before the

cord, near outer end of cell *M* and in the bases of cells *M*, *1st A* and *2nd A;* antestigmal and poststigmal regions more creamy-white; veins dark brown, R_2 paler; obliterative areas extensive. Venation: R_{1+2} long, entire, cell R_2 deep; cell M_1 very deep, the petiole greatly reduced; *m-cu*, basal section of M_3 and *m* in oblique sinuous alignment.

Abdominal tergites yellow, passing into brownish yellow on the outer segments, trivitate with black, the stripes narrowly interrupted at the incisures; sternites similar, with a conspicuous median black longitudinal line, the outer segments more uniformly darkened. Male hypopygium as in the *moctezumæ* group; ninth tergite large, the caudal margin with a broad, rectangular notch, the median area of which is gently produced and again split by a tiny median V-shaped notch; lateral lobes flattened, the tips obtusely rounded. The conspicuous outer dististyle lies caudad of the inner, narrow at base, expanded outwardly, the caudal portion of the apex further extended into a triangular lobe. Ovipositor with the valves very long and straight, the margins smooth.

Holotype, ♂, near Gruta del Elcanto, Chiapas, in pine forest, altitude about 2,200 meters, June 6, 1926 (A. M. Dampf). *Allotopotype*, ♀, with the type. *Paratopotype*, ♂, M. B. 162; *paratypes*, ♀, San Cristobal, July 12, 1926, M. F. 1,030; 1 ♀, June 4, 1926, M. B. 160; 1 ♀, Summit of the Hueitepec, altitude 2,600 meters, June 14, 1926, M. F. 971.

The specific name is that of a Maya tribe of Chiapas.

Tipula zotzil sp. n.

Male. Length about 16 mm.; wing, 18 mm.; antenna about 9.5 mm.

Female. Length about 22 mm.; wing, 18.5 mm.

Belongs to the *monilifera* group; allied to *T. mitua* Alexander (Colombia), from which it differs as follows:

Antennæ a little longer in proportion to the length of the body. Frontal prolongation of head dark brown laterally, conspicuously yellow above. Antennæ with the scape and first flagellar segment yellow; second flagellar segment with the stem brownish yellow; remaining flagellar segments with the stem passing from dark brown into black, concolorous with the basal node. The head and thorax are discolored and their coloration cannot be well compared. Pleura yellow. Wings much as in *mitua*, the white areas more restricted, the oblique white band across cells *R* and *M* very narrow and the subbasal white areas in the same cells merely indicated; basal half of vein R_{1+2} dark brown, the distal half abruptly pale. Male hypopygium large, the ninth tergite black on the sides, the caudal margin and median area broadly yellow; tergite narrowed apically, the caudal margin gently rounded, almost as in *mitua*. Dististyle light yellow, conspicuous. Median area of the eighth sternite a low blunt lobe that is only about as long as the width at base, the apex obtuse, tufted with golden-yellow setæ that are longer than the lobe itself.

Holotype, ♂, Hueitepec, Chiapas, in dense leafy woods, altitude 2,600 meters, June 14, 1926 (A. M. Dampf); M. B. 170. *Allotype*, ♀, San Cristobal, in midst of meadows, swept from hanging branches of willows near rivulet, July 3, 1926; M. B. 183.

The specific name is that of a native Indian tribe of Chiapas. The *monilifera* group and its included species has been discussed in an earlier paper by the writer (Trans. Amer. Ent. Soc., 42: 23-30, pls. 3-5; 1916). *T. zotzil* is the most northern species so far discovered. Osten Sacken (Biol. Centr.-Amer., Dipt. 1: 13; 1886) refers specimens from Irazu, Costa Rica, to *monilifera*, with a question.

Dicranomyia Stephens.

Dicranomyia onerosa sp. n.

Similar to *D. liberta* O. S.; general coloration gray; antennæ black throughout; wings strongly tinged with dusky, the small stigma darker; male hypopygium with the rostral prolongation of the ventral dististyle stout, bearing a single spine which arises from an enlarged basal papilla.

Male. Length about 5.3–5.5 mm.; wing, 7.4 mm.

Very similar in general appearance to the Nearctic *D. liberta* Osten Sacken, differing notably in the structure of the male hypopygium. Rostrum, palpi and antennæ black, the flagellar segments oval. Head and thorax brownish gray, the praescutal stripes and centers of the scutal lobes darker. Halteres pale, the knobs dark brown. Legs dark brown, the tips of the femora broadly blackened, the tibiæ more narrowly so; tarsi brownish black. Wings strongly suffused with dusky, the small, ill-delimited stigma darker brown; vague darker seams along the cord and outer end of cell *1st* M_2; obliterative areas conspicuous, including part of *m-cu*. Venation: *Sc* short, Sc_1 ending shortly beyond the origin of *Rs*, Sc_1 not far from the tip and about opposite the origin of *Rs; m-cu* varying in position from some distance before to opposite the fork of *M*. In the right wing of the type, cell M_2 is open by the atrophy of the outer deflection of M_3.

Abdomen, including the hypopygium, dark brown. Male hypopygium with the rostral prolongation of the ventral dististyle stout, near midlength bearing a single conspicuous spine which arises from a swollen papilla.

Holotype, ♂, San Cristobal, Chiapas, altitude 2,100 meters, July 12, 1926 (A. M. Dampf); M. F. 1,030. *Paratopotype*, ♂.

Dicranomyia ingrata sp. n.

Male. Length about 5.5 mm.; wing, 7.6 mm.

Female. Length about 6 mm.; wing, 7.5 mm.

Praescutal stripes brown, the lateral stripes poorly delimited. Legs with the femora light brown, the tips broadly blackened; remainder of legs black. Wings almost exactly as in *onerosa*, with *Rs* a little shorter. Abdomen with the hypopygium dark brown. Male hypopygium with the margin of the ninth tergite evenly convex, not at all emarginate. Ventral dististyle relatively small, the rostral prolongation broad, with two spines, these arising from small, equal, elevated tubercles that are separated from one another by a distance a little less than the width of one; spines of moderate length, subequal, acutely pointed. Dorsal dististyle a strongly curved sickle-shaped rod, the long apex very slender and acutely pointed; basal portion stouter, narrower at midlength, a trifle dilated before the long apical portion. Gonapophyses with the mesal apical angle long, slender, gently curved, the lateral margin microscopically roughened.

Holotype, ♂, Cerro San Cristobal, Chiapas, on low herbage, June 29, 1926 (A. M. Dampf); M. B. 182. *Allotype*, ♀, San Cristobal, altitude 2,100 meters, at light, July 12, 1926; M. F. 1,030.

Dicranomyia subravida sp. n.

Generally similar to *D. ravida* Alexander; antennæ black throughout; rostral prolongation of the ventral dististyle of the male hypopygium with two subequal spines that are directed strongly basad.

Male. Length about 5 mm.; wing, 5-5.5 mm.

Female. Length about 5-5.5 mm.; wing, 6-6.5 mm.

Rostrum brownish yellow, the palpi black. Antennæ black throughout, the first segment sparsely pruinose; flagellar segments short-oval, decreasing in size outwardly. Head gray, the vertex more or less darkened, the posterior orbits clear.

Mesonotum yellowish gray, the praescutum with three dark brown stripes, the median stripe broad, the laterals sometimes obsolete, sometimes more distinct. Pleura gray. Halteres yellow, the knobs infuscated. Legs with the coxæ pale, the fore coxæ infuscated, the remaining coxæ infuscated only at bases; trochanters yellow; femora dark brown, the bases narrowly obscure yellow; tibiæ brown, the tips narrowly dark brown; outer tarsal segments brownish black. Wings hyaline, the oval stigma pale brown; veins brown. Venation: *Sc* relatively short, Sc_1 ending some distance before the origin of *Rs*, Sc_2 far from the tip of Sc_1, the latter alone about equal to *m-cu; Rs* short, subequal or shorter than the basal section of R_{4+5}, strongly arcuated to feebly angulated; cell *1st* M_2 closed; *m-cu* at or before the fork of *M*, subequal to or a little shorter than the distal section of Cu_1.

Abdomen dark brown, the surface pruinose; ventral dististyle of hypopygium yellow. Male hypopygium with the ninth tergite nearly transverse across the caudal margin, the lateral lobes very low, each with a group of about ten setæ; a median group of about seven setæ.

Generally similar to *D. onerosa* sp.n., differing especially in the structure of the male hypopygium.

Basistyle relatively small, the ventro-mesal lobe large. Ventral dististyle large and fleshy, the rostral prolongation broadly flattened, with two subequal spines that are directed strongly basad. Dorsal dististyle gently curved, sinuous. Gonapophyses very broad, the caudomesal angle produced into a relatively slender lobe.

Holotype, ♂, San Cristobal, Chiapas, altitude 2,100 meters, July 12, 1926 (A. M. Dampf); M. B. 188. *Allotopotype*, ♀; M. B. 183. *Paratopotypes*, 20 ♂ ♀, June 9–July 23, 1926; M. B. Nos. 163, 164, 165, 166, 173, 179, 183, 185, 188, 193, 194; M. F. Nos. 973, 1,005, 1,006, 1,007, 1,008, 1,015, 1,021 and 1,031.

Geranomyia Haliday.

Geranomyia pentheres sp. n.

Related to *G. canadensis* Westwood; legs uniformly brownish black; wings with a strong dusky suffusion, the oval stigma darker brown; abdominal tergites uniformly dark brown; male hypopygium with the spines of the rostral prolongation of the ventral dististyle very long, curved, arising from a single conspicuous tubercle.

Male. Length (excluding rostrum) about 5 mm.; wing, 6.8 mm.; rostrum about 4 mm.

Rostrum elongate, black, the palpi concolorous. Antennæ brownish black throughout; flagellar segments oval or the outer apical angles a little produced. Head dark gray.

Mesonotal praescutum reddish brown, the median stripe more plumbeous, indicated posteriorly; humeral region of praescutum brighter; scutal lobes dark plumbeous; scutellum more brownish testaceous; postnotum, including the pleurotergite, plumbeous gray. Pleura obscure brownish yellow. Halteres dark brown, the base of the stem narrowly pale. Legs with the coxæ and trochanters testaceous; remainder of the legs brownish black, the femoral bases only narrowly paler. Wings with a strong dusky suffusion, the oval stigma darker brown, conspicuous; veins still darker brown. Venation: *Sc* relatively long, Sc_1 extending to midlength of *Rs*, Sc_2 not far from its tip; *Rs* long and straight; R_1 present but very short, Sc_2 thus lying just proximad of R_2; cell *1st* M_2 closed; *m-cu* shortly before the fork of *M*; cell *2nd A* relatively narrow.

Abdominal tergites dark brown, the basal sternites more yellowish. Male hypopygium with the tergite deeply emarginate, the conspicuous lateral lobes densely set with spinous setæ. Ventral dististyle very large and fleshy, the rostral prolongation short, with a very large and conspicuous fleshy tubercle occupying about all of its outer surface, this long tubercle bearing both of the long curved rostral spines, these latter lying close together and subequal in length, approximately as long as the dorsal dististyle. Dorsal dististyle a curved sickle-shaped rod, narrowed very gradually to the obtuse apex. Gonapophyses with the mesal lobes elongate, the apex produced into a weak spinous point.

Holotype, ♂, near San Cristobal, Chiapas, in the shadowy ravine of a mountain brook, July 17, 1926 (A. M. Dampf); M. B. 190a. *Paratopotype*, ♂.

Geranomyia turbida sp. n.

Related to *G. canadensis* Westwood; mesonotal praescutum yellow with scarcely evident fulvous stripes; pleura yellow; legs with the femora dark brown, the tips narrowly obscure yellow; wings with a yellowish brown suffusion, the oval stigma darker brown; abdominal tergites darker brown; male hypopygium with the ventral dististyle very large and fleshy, the rostral prolongation short, with two short straight spines.

Male. Length (excluding rostrum) about 6-6.4 mm.; wing, 7-8 mm.; rostrum about 3.5–4 mm.

Rostrum relatively elongate, brownish black, paler basally. Antennæ brownish black throughout; flagellar segments oval. Head above brownish gray, the vertex with a vague darker median line; anterior vertex relatively wide.

Mesonotal praescutum light yellow, with scarcely evident fulvous stripes; scutum yellow, the centers of the lobes darker; scutellum clearer yellow; postnotum more infuscated. Pleura yellowish. Halteres relatively short, dark brown, the base of the stem narrowly yellow. Legs with the coxæ and trochanters obscure yellow; femora dark brown, a trifle paler basally, the tip narrowly but rather conspicuously light yellow; tibiæ brownish black, the tips and the tarsal segments a little paler. Wings with a bright yellowish brown suffusion, the oval stigma darker; veins dar brown. Venation: *Sc* long, Sc_1 ending about opposite two-thirds the length of *Rs*, Sc_2 close to its tip; free tip of Sc_2 some distance before R_2, R_1 thus being relatively elongate; cell *1st* M_2 rectangular, gently widened outwardly; *m-cu* not far from the fork of *M*, longer than the distal section of Cu_1.

Abdominal tergites dark brown, the sides paler; sternites more testaceous yellow; hypopygium dark. Male hypopygium with the caudal margin of the ninth tergite only gently emarginate, the lateral lobes broad. Ventral dististyle very large and fleshy, elongate; rostral prolongation short and stout, provided with two short, straight spines of which the outer one is a trifle shorter; the spines are placed close together near the base of the prolongation, not arising from enlarged basal swellings as in related species. Dorsal dististyle pale, gently curved, the tip abruptly narrowed to an acute point.

Holotype, ♂, near San Cristobal, Chiapas, in shaded ravine of mountain brook, altitude about 2,200 meters, July 17, 1926 (A. M. Dampf); M. B. 190a. *Paratopotypes*, 3 ♂♂, July 15, 1926; M. B. 190; July 17, 1926; M. B. 190a.

Geranomyia eurygramma sp. n.

Antennæ black throughout; mesonotal praescutum light green, with a broad dark brown median stripe and less evident orange-brown

lateral stripes; wings yellowish, with an extensive brown pattern; *Sc* short; male hypopygium with the spines of the rostral prolongation of the ventral dististyle unequal, arising from conspicuous tumid bases.

Male. Length (excluding rostrum) about 6–6.5 mm.; wing, 6.5–7 mm.; rostrum about 2.9 mm.

Female. Length (excluding rostrum) about 7.5–8 mm.; wing, 7.8 mm.; rostrum about 3.2–3.5 mm.

Rostrum relatively long, black, in the male a little less than one-half the length of the body; palpi black. Antennæ black throughout; flagellar segments elongate-oval. Head brownish gray, the vertex with a narrow median light gray vitta.

Mesonotal praescutum light green with a very broad, dark brown median stripe and less evident orange-brown sublateral stripes, the broad lateral margins remaining of the ground-color; scutum pale, the centers of the lobes extensively dark brown; scutellum green; postnotum pale brown, with greenish reflections. Pleura pale reddish or testaceous brown, with green reflections. Halteres short, pale, the knobs dark brown. Legs with the coxæ pale, tinged with green; trochanters pale yellow; femora light brown, the tips broadly yellow, preceded by a subequal darker brown annulus; in cases, this latter ring is preceded by a broader but more diffuse obscure yellow ring; tibiæ and tarsi brown, the terminal tarsal segments darker. Wings with a yellowish tinge, cell *Sc* more strongly so; an extensive darker pattern, arranged as follows: A series of about four darker brown areas along the costa, the first just beyond *h*, the second at the supernumerary crossvein, the third at origin of *Rs* and end of *Sc*, the fourth the stigmal area; cord and outer end of cell *1st* M_2 broadly seamed with paler brown; pale brown marginal clouds at ends of veins R_3, Cu_1 and very extensively on both Anal veins; veins yellow, brown in the infuscated areas. Venation: Sc_1 ending a short distance beyond the origin of *Rs*, Sc_2 near its tip and likewise beyond *Rs;* a supernumerary crossvein in cell *Sc; Rs* feebly angulated at origin; *m-cu* at fork of *M;* cell *2nd A* broad.

Abdominal tergites brown, the sternites more greenish yellow. Male hypopygium with the ninth tergite having a relatively narrow U-shaped median notch, the broad lateral lobes thus formed conspicuously setiferous. Ventral dististyle very large and fleshy, the rostral prolongation slender, near its base with two very conspicuous, strongly divaricate spines that arise from tumid bases; spines slightly unequal in size, one arising from a base that is nearly as large as the rostral prolongation beyond it, the spine long and straight; the second spine arises from a shorter and broader base, is only about two-thirds as long as the other and is strongly bent at base.

Holotype, ♂, Córdoba, Barranca of the Rio San Antonio, altitude 870 meters, November 20, 1924 (A. M. Dampf); M. B. 102. *Allotopotype*, ♀. *Paratopotypes*, 6 ♂ ♀.

Geranomyia perfecta sp. n.

General coloration gray, the praescutum with three dull black stripes; scutal lobes black, the median area obscure yellow; pleura pale ochreous, with longitudinal brown stripes; femora brownish yellow, the tips blackened, preceded by a vague yellowish subterminal ring; wings whitish, the oval stigma dark brown; paler brown seams on the cord, outer end of cell *1st* M_2 and the wing-tip; *Sc* long; abdomen dark brown.

Female. Length (excluding rostrum) about 8.5 mm.; wing, 7.5 mm.; rostrum about 3.5 mm.

Rostrum elongate, as shown by the measurements, black throughout, including the palpi. Antennæ black throughout, the flagellar segments oval to short-cylindrical. Head dark gray, the center of the vertex with a darker line; anterior vertex brighter; sides of the genæ obscure yellow.

Pronotum dark brown, the posterior notum obscure yellow laterally. Mesonotal praescutum with three dull black stripes, the median stripe vaguely divided behind; humeral triangles obscure fulvous, the interspaces and lateral margins of the sclerite more infuscated; scutum obscure yellow medially, the lobes black; scutellum obscure yellow, the base on either side of the median line narrowly infuscated; postnotum dark gray, margined laterally with paler. Pleura chiefly pale ochreous, longitudinally variegated with brown on the anepisternum and ventral sternopleurite; pleurotergite gray. Halteres dark brown, the base of the stem narrowly pale. Legs with the fore coxæ dark brown, the middle and hind coxæ less distinctly darkened; trochanters obscure testaceous; femora brownish yellow, paler basally, the tips rather narrowly blackened, the amount subequal on all the legs; a vague subterminal yellowish ring; tibiæ yellowish brown, the tips narrowly dark brown; basitarsi brown, the tips and remainder of tarsi brownish black. Wings whitish, the stigma oval, dark brown; cell *Sc* darkened; a tiny brown cloud at origin of *Rs;* cord and outer end of cell *1st* M_2 seamed with grayish; wing-tip in cells Sc_2 to M_3 distinctly infumed; veins black, the obliterative areas extensive. Venation: *Sc* moderately long, Sc_1 ending about opposite midlength of *Rs*, Sc_2 close to the tip of Sc_1; *Rs* approximately three times the basal section of R_{4+5}; *m-cu* at the fork of *M*.

Abdomen dark brown, including the genital segment. Ovipositor with the tergal valves short and slender, the sternal valves straight, darkened.

Holotype, ♀, near Tepic, Nayarit, altitude 3,069 feet, swept from shrubs and bushes on shores of a swift-flowing rivulet, March 14, 1927 (A. M. Dampf); M. B. 203. *Paratopotype*, ♀; M. F. 1191.

Epiphragma Osten Sacken.

Epiphragma oreonympha sp. n.

General coloration dark brown, the anterior portion of the praescutum paler; antennæ (♂) elongate, the first flagellar segment yellow; halteres elongate, brownish black; femora with the apical third yellow, enclosing a broad black subterminal ring; wings long and narrow, subhyaline, with an ocelliform brown pattern; abdominal tergites dark brownish black, the sternites yellow; hypopygium dark brown.

Male. Length about 9–10 mm.; wing, 10.5–12.5 mm.; antennæ about 4.3–4.6 mm.

Female. Length about 11 mm.; wing about 10 mm.

Rostrum and palpi black. Antennæ (♂) elongate, if bent backward extending nearly to the base of the fourth abdominal segment; scape black; first flagellar segment yellow; remainder of organ black; flagellar segments elongate-cylindrical, the basal enlargement small. Head brown, darker medially; anterior vertex (♂) very narrow.

Pronotum chiefly dark brown; anterior lateral pretergites yellow. Mesonotal praescutum light golden to ochreous brown, the posterior half dark brown, the usual intermediate stripes more or less distinct throughout their whole length; humeral triangles and the broad lateral margins of the sclerite black; scutum light brown, the lobes and the median area variegated with dark brown; scutellum and postnotum dark, conspicuously pruinose. Pleura brownish black, with paler areas on the meron and ventral portion of the pteropleurite, and immediately beneath the wing-root; dorso-pleural region dusky. Halteres elongate, brownish black, only the extreme base of the stem yellowish. Legs with the coxæ obscure yellow, the bases narrowly dark brown, most extensive on the fore coxæ where the basal half is included, narrowest on the posterior coxæ; in some specimens, the middle and posterior coxæ are uniformly pale; trochanters obscure yellow; femora brown, paler basally, the apical third yellow enclosing a broad, conspicuous black ring, about equal in extent to the combined yellow apex and subterminal annulus; tibiæ brown, the base narrowly yellow, the extreme tip very narrowly pale; tarsi paling into golden yellow, especially the posterior tarsi. Wings relatively long and narrow, subhyaline, with a handsome ocelliform brown pattern; cell *Sc* more yellowish; brown seams at *h* and the supernumerary crossvein in cell *C*, between these two latter two broad, pale brown areas that are margined laterally with dark brown, the marks continued caudad into cell *Sc;* a similar but smaller area at end of vein *Sc;* stigma elongate-oval, darker brown; ocelliform markings broken, the principal ones having the following points as centers: Origin of *Rs;* anterior cord; *m;* fork of M_{1+2}, these centers being of a darker brown than the rings; marginal areas at the ends of all the longitudinal veins, largest in cells R_2 and R_3; a large gray cloud extends across cells *Cu* and *1st A* from the ocellus at the origin of *Rs;* the long, narrow cell *2nd A* is almost uniformly grayish brown,

interrupted by the ground-color near the base, and, in cases, near the outer end; outer end of cell *1st A* extensively clouded in similar manner; veins dark brown. Venation: Cells beyond the cord long and narrow, the veins with conspicuous macrotrichiæ; R_{2+3+4} longer than R_{2+3}; *m-cu* about its own length beyond the fork of *M*, transverse in position; cell *2nd A* long and narrow.

Abdominal tergites brownish black, the caudal margins of the segments narrowly pale; a lateral yellow spot at near two-thirds the length of the intermediate segments; sternites yellow; hypopygium dark brown.

Holotype, ♂, near San Cristobal, Chiapas, July 17, 1926 (A. M. Dampf); M. B. 190a. *Allotype*, ♀, Huixtan, Chiapas, altitude 2,700 meters, in virgin forest, July 7, 1926 (A. M. Dampf); M. F. 1022. *Paratopotype*, ♂, with the allotype.

Epiphragma oreonympha is allied to *E. circinata* Osten Sacken (Costa Rica) in the elongate antennæ of the male. It differs in the details of coloration, especially of the thorax and abdomen, and in the long, narrow wings. The halteres are not brightened at their tips.

Shannonomyia Alexander.

Shannonomyia moctezuma sp. n.

Allied to *S. lenta* (Osten Sacken), most closely allied to *S. lentoides* (Alexander); antennæ relatively long, in the male if bent backward extending about to the base of the abdomen; wings with a strong brownish tinge, the broad costal margin darker brown, the central portion pale, producing a longitudinal whitish stripe that extends to the wing-tip.

Male. Length about 6 mm.; wing, 7.5 mm.

Rostrum and palpi dark brown. Antennæ relatively elongate for a member of this group; scapal segments a trifle paler than the dark brown flagellum; if bent backward, the antennæ extend approximately to the base of the abdomen; antennal segments long-oval, with a dense, erect, white pubescence. Head gray.

Mesonotum dark brownish gray, the praescutum with three scarcely evident darker brownish gray stripes. Pleura brown, uniformly pruinose. Halteres pale, the knobs scarcely darkened. Legs with the coxæ and trochanters brownish yellow; femora yellow, the tips weakly darkened; tibiæ brownish yellow, the tips narrowly darkened; tarsi pale brown, the terminal segments dark brown. Wings with a strong brownish tinge, especially the costal third, the posterior third a little paler, the central third nearly clear, to produce a longitudinal pale stripe that extends from the arculus to the wing-apex, including all of cell R_5; indistinct brown seams at origin of *Rs*, along cord and outer end of cell *1st* M_2; stigma small, restricted to R_2; veins brown, darker in the infuscated areas. Venation: *Sc* relatively short, Sc_1 ending shortly

before the end of *Rs*, Sc_2 near its tip; *Rs* short, arcuated at origin; R_2 about equal to R_{1+2} and a trifle longer than R_{3+4}; R_3 and R_4 strongly divergent at ends; cell *1st* M_2 long and narrow, *m-cu* near midlength.

Abdomen dark brown, the ninth tergite and proximal portions of the basistyles of the male hypopygium a little brightened. Male hypopygium with the dististyles broadly united basally by pale membrane; apex of the outer dististyle weakly bifid, narrowly blackened. Aedeagus relatively long.

Holotype, ♂, Desierto de los Leones, altitude 3,100 meters, in *Abies* forest, swept from along a swift-flowing aqueduct, March 29, 1925 (A. M. Dampf); M. B. 116. *Paratopotype*, ♂.

Shannonomyia lentina sp. n.

Allied to *S. lenta* (Osten Sacken); general coloration light gray, the praescutum with three inconspicuous, darker gray stripes; sternopleurite conspicuously pale; wings yellowish, the stigma oval, pale brown; male hypopygium with the aedeagus short.

Male. Length about 5 mm.; wing, 6 mm.

Female. Length about 7.5 mm.; wing, 7.5–8 mm.

Rostrum and palpi brownish black. Antennæ (♂) relatively elongate, if bent backwards extending nearly to the root of the halteres; scapal segments brownish yellow, the flagellum brownish black; flagellar segments long-oval, becoming smaller outwardly. Head dark gray, the anterior vertex and posterior orbits clear light gray.

Pronotum above pale gray. Mesonotum light gray, the praescutum with three darker gray stripes that are relatively inconspicuous; humeral region slightly reddish; scutellum slightly reddish behind; postnotum gray. Pleura dark, the sternopleurite largely buffy yellow, the anepisternum darker, to produce a dorsal longitudinal stripe from the cervical sclerites to below the wing-root; dorso-pleural membrane pale. Halteres pale yellow. Legs with the coxæ obscure yellow; trochanters a little darker; femora brownish yellow, a trifle darkened outwardly; tibiæ pale brown, the tips weakly infuscated; tarsi pale, passing into black at the ends of the basitarsi. Wings yellowish, the oval stigma pale brown; vague, pale brown seams at origin of *Rs*, along the cord and outer end of cell *1st* M_2; veins pale yellow, those in the infuscated areas a little darker. Venation: R_2 about equal to R_{1+2} and a little longer than R_{2+3}; veins R_3 and R_4 relatively short, diverging markedly; cell *1st* M_2 small, widened outwardly, *m-cu* at or before midlength, variable in position; in the type it is only a little shorter than the distal section of Cu_1, in other cases scarcely one-half this length.

Abdomen dark brown, the ninth segment and basal portion of the basistyles obscure yellow. Male hypopygium with the outer dististyle conspicuously split at apex. Gonapophyses relatively small. Aedeagus short.

Holotype, ♂, near San Cristobal, Chiapas, in narrow, shaded ravine of small mountain brook, altitude nearly 2,200

meters, July 15, 1926 (A. M. Dampf); M. B. 190a. *Allotopotype*, ♀. *Paratopotype*, ♀; *paratypes*, ♂, ♀, Valle de San Cristobal, in oak forest, the ground covered with leaves, July 23, 1926 (A. M. Dampf); M. B. 194.

Limnophila Macquart.

Limnophila madida sp. n.

Male. Length about 8 mm.; wing, 10 mm.

Female. Length about 10 mm.; wing, 10–10.5 mm.

Generally similar to *L. guttulatissima* Alexander (Guatemala—Costa Rica), differing especially in the coloration of the legs and the structure of the male hypopygium.

Rostrum, palpi and antennæ dark throughout. Head brownish gray, the setigerous punctures appearing as dark brown dots. Legs with the femora yellow, the tips very broadly blackened, on the fore legs including about the distal fourth, on the posterior legs including about the distal fifth; tips of the tibiæ conspicuously blackened; basitarsi yellow, the tips and remainder of the tarsi blackened. Male hypopygium with the aedeagus relatively short and strongly sinuous. Gonapophyses slender, their tips acute.

Holotype, ♂, San Cristobal, Chiapas, altitude 2,100 meters, July 6, 1926 (A. M. Dampf); M. B. 184. *Allotopotype*, ♀, pinned with the type. *Paratopotypes*, numerous ♂, ♀, June 4–July 6, 1926 (A. M. Dampf); M. B. 173, 183, 184, 185; M. F. 942-952, 960, 973.

Atarba Osten Sacken.

Atarba (Atarba) **amabilis** sp. n.

General coloration light chestnut-brown, the postnotum and pleura darker; antennæ black, the incisures of the segments conspicuously light yellow; legs yellow, the terminal tarsal segments darker; wings with a grayish yellow suffusion, the stigma darker; *Sc* ending beyond the origin of the long angulated *Rs*.

Female. Length about 6.5 mm.; wing, 7.5 mm.

Rostrum golden-yellow; palpi brownish black. Antennæ elongate for the female sex, if bent backward extending about to the base of the abdomen; scapal segments obscure yellow; flagellum black, the base of each segment broadly, the tips more narrowly, yellow, to produce an annulated appearance; flagellar segments elongate-cylindrical. Head brown, lighter in front and on the occiput.

Mesonotal praescutum and scutum uniformly light chestnut-brown, the surface shiny, without markings; scutellum more testaceous; postnotum pale, the surface pruinose. Pleura pale brown, the surface very sparsely pruinose, the dorso-pleural region dark. Halteres pale, the

knobs dark brown. Legs with the coxæ and trochanters yellowish testaceous; femora yellow, the tips of the fore femora very narrowly and inconspicuously infumed, the other femora undarkened; remainder of legs obscure yellow, the terminal tarsal segments passing into dark brown. Wings with a grayish yellow suffusion, the base and costal region clearer yellow; stigma elongate-oval, pale brown; veins dark yellow. Venation: Sc_1 ending shortly beyond the origin of *Rs*, Sc_2 at its tip and likewise beyond this origin; *Rs* relatively long for a member of this genus, about as in *columbiana*, strongly angulated at origin; cell R_2 at margin narrower than cell R_3; cell *1st* M_2 relatively large, irregularly pentagonal; *m-cu* shortly beyond the fork of *M*.

Abdominal tergites dark brown, the sternites and genital segments obscure yellow. Ovipositor with the tergal valves slender, gently upcurved, the tips acute; sternal valves very deep.

Holotype, ♀, near San Cristobal, Chiapas, in a narrow, shadowy ravine, July 17, 1926 (A. M. Dampf); M. B. 190a.

Atarba amabilis is most closely related to *A. columbiana* Alexander (Colombia). By means of the writer's key to the species of *Atarba* (Annals Ent. Soc. America, 19:171; 1926), the present form runs to *megaphallus* Alexander, with which it agrees in coloration of the antennæ, but differs in other respects, notably the venation.

Elephantomyia Osten Sacken.

Elephantomyia fumipes sp. n.

General coloration fulvous-yellow, in cases with a conspicuous median brown stripe on the pronotum and praescutum; rostrum longer than the body; femora and tibiæ dark brown; wings with a strong brownish tinge, the center of the disk brighter; *Rs* long, arcuated to weakly angulated at origin.

Male. Length (excluding rostrum) about 7 mm.; wing, 10.5 mm.; rostrum about 8 mm.

Female. Length (excluding rostrum) about 9 mm.; wing, 10.5 mm.; rostrum about 9–9.5 mm.

Rostrum elongate, dark brown, approximately as long as, or slightly longer than, the remainder of the body. Antennæ dark. Head obscure yellow, the center of the vertex darker; anterior vertex very narrow.

Cervical sclerites dark brown. Pronotum and mesonotum bright fulvous-yellow, with a conspicuous, median, brown stripe ending just before the suture; scutum yellow, the mesal portions of the lobes conspicuously darkened; scutellum and postnotum dark brown, paler laterally. Pleura shiny fulvous-yellow, the sternopleurite a little darker. Halteres pale, the knobs darker. Legs with the coxæ and trochanters yellowish testaceous; remainder of legs dark brown, the femoral bases a little brighter, the tarsi fading into obscure orange. Wings with a strong brown tinge, especially along the costal region,

beyond the cord, and in the anal cells, cells *R* and *M* being somewhat brighter, especially near vein *M;* stigma elongate-oval, darker brown; veins brown. Venation: *Sc* long, Sc_1 and Sc_2 ending opposite or beyond the fork of *Rs*, the latter long, arcuated to weakly angulated at origin.

Abdominal tergites brown, the bases of the segments indistinctly variegated with obscure yellow; a subterminal black ring that includes segment eight and the caudal portion of segment seven; hypopygium obscure yellow.

In the female, the dorsal median praescutal line is not evident and the tarsal segments are not so conspicuously pale.

Holotype, ♂, Hueitepec, Chiapas, altitude 2,600 meters, in dense leafy woods, June 14, 1926 (A. M. Dampf); M. B. 170. *Allotype*, ♀, near San Cristobal, altitude 2,250 meters, in dense forest of oaks and pines, July 7, 1926 (A. M. Dampf); M. B. 186.

Elephantomyia fumipes is very different from the other described Mexican species, *E. alticola* Alexander. It is closer to *E. westwoodi* Osten Sacken, differing in the coloration of the wings and legs and in the venation.

Teucholabis Osten Sacken.

Teucholabis (Teucholabis) **cinereiceps** sp. n.

General coloration shiny coal black, this including the entire disk of the praescutum; head above silvery gray; pleura with a broad silvery white longitudinal stripe; knobs of the halteres yellow; wings subhyaline, the stigma dark brown; abdomen black, the sternites banded with yellow.

Male. Length, 4.8–5 mm.; wing, 5.5–6 mm.

Rostrum obscure yellow; palpi brownish black. Antennæ brownish black, the basal segment of the scape a little brightened beneath; flagellar segments subglobular, the outer segments passing into oval. Head blackish, the whole dorsal surface with a dense silvery gray pubescence; vertex broad.

Pronotum and lateral pretergites yellow. Mesonotal praescutum shiny coal black, with an obscure yellow median spot just before the suture, crossing the latter onto the median region of the scutum; scutum obscure yellow medially, with a silvery pubescence behind, the lobes extensively shiny black, confluent across the suture with the praescutal shield; scutellum obscure yellow, darker laterally; postnotum black, sparsely pruinose anteriorly. Propleura yellow. Mesopleura black, with a broad pale longitudinal stripe extending from behind the fore coxæ, passing beneath the halteres to the hind coxæ, this stripe densely covered with microscopic silvery white pubescence; meron pale. Halteres dark, the knobs obscure yellow. Legs with the coxæ and trochanters obscure brownish yellow; fore femora yellow basally, passing into black at tip; middle and hind femora not darkened apically; posterior tibiæ brownish yellow, the fore tibiæ more blackened, the middle tibiæ dark brown; tarsi black. Wings subhyaline, the sub-

circular stigma dark brown; a vague brown seam on the anterior cord; basal half of cell *Sc* infumed; veins dark brown. Venation: *Sc* relatively short, Sc_1 ending about opposite one-fourth to one-fifth the length of *Rs*, Sc_2 variable in position, in the type removed from the tip of Sc_1, in the paratype closer to the end; *Rs* long, strongly arcuated; R_2 at or slightly before the fork of *Rs*; R_{3+4} and R_4 beyond it relatively straight, R_5 bent strongly to the wing-tip so cell R_4 is very wide at the margin; *m-cu* close to or before the fork of *M*.

Abdominal tergites black, the segments restrictedly variegated laterally with obscure yellow; sternites black, the caudal margins of the segments broadly banded with obscure yellow, the outer sternites more uniformly pale; hypopygium black. Male hypopygium with both dististyles blackened and each terminating in a chitinized spine.

Holotype, ♂, Peña Blanca, December 15, 1924 (A. M. Dampf); M. B. 109. *Paratopotype*, ♂.

Teucholabis cinereiceps is readily distinguished from similarly colored species by the silvery gray head and plain wings. The locality was discussed in some detail in a preceding part under this title (Annals Ent. Soc. America, 19:171; 1926).

Gonomyia Meigen.

Gonomyia (Gonomyia) **debilis** sp. n.

Belongs to the *cognatella* group; size small (wing, ♀, under 4 mm.); pleura yellow with a single narrow brown stripe; abdominal tergites dark brown, the caudo-lateral angles obscure yellow.

Female. Length about 3.3–3.5 mm.; wing, 3.6–3.8 mm.

Rostrum and palpi black. Antennæ with the first scapal segment orange; second segment yellow; flagellum dark brown. Head orange-yellow, the center of the vertex more or less darkened.

Pronotum yellow. Mesonotal praescutum grayish brown, the lateral margins yellow, the pseudosutural foveæ large but pale and inconspicuous; scutal lobes brown, the median area obscure yellow; scutellum testaceous; postnotum pale brown, paler laterally, the caudal margin narrowly darkened. Pleura pale, with a single narrow dark brown longitudinal stripe extending from the cervical sclerites to the postnotum, passing above the root of the halteres; sternopleurite very weakly darkened; dorso-pleural region clearer yellow. Halteres relatively long, brown. Legs with the coxæ and trochanters testaceous; remainder of legs brownish testaceous, the terminal tarsal segments passing into darker brown. Wings with a brownish gray tinge, the small stigma a little darker brown; veins still darker brown. Venation: *Sc* short, Sc_1 ending far before the origin of *Rs*, Sc_2 a short distance from its tip, the distance on radius between Sc_2 and origin of *Rs* about twice *m-cu*; *Rs* nearly if not quite in alignment with R_5; R_{2+3+4} nearly in alignment with *r-m*, the veins at the end of *Rs* thus forming a cruciform arrangement; petiole of cell R_3 strongly arcuated, about one-third

longer than R_3; R_4 about three times as long as R_3; cell M_2 open by the atrophy of the deflection of M_3; *m-cu* shortly before the fork of *M*.

Abdominal tergites dark brown, the caudo-lateral angles of the segments obscure yellow; sternites obscure testaceous yellow.

Holotype, ♀, San Isabel, Chiapas, altitude about 650 meters, July 30, 1926 (A. M. Dampf); M. F. 1,057. *Paratopotype*, ♀.

Gonomyia (Lipophleps) **peracuta** sp. n.

Male. Length about 3.5 mm.; wing, 3.1–3.2 mm.

Belongs to the *pleuralis* group; very distinct in the structure of the male hypopygium.

Rostrum and palpi brownish black. Antennæ with the scapal segments orange; flagellum brownish black, with very long verticils in the male. Mesonotum bright cinnamon brown; scutellum yellow with a narrow brownish black median line; postnotal mediotergite reddish brown with a darker spot at base. Pleura with the two brown stripes very distinct, a little narrower than the white stripe enclosed; dorso-pleural region more or less darkened, especially in front. Halteres pale, the tips of the knobs yellowish. Legs with the femora brown, the tips narrowly but conspicuously whitened, preceded by a broader dark brown subterminal ring. Wings faintly tinged with brown, the base and costal region clearer yellow; conspicuous cream-colored areas before and beyond the stigma and along the cord; stigma oval, dark brown; veins pale, the cord and outer end of cell *1st* M_2 dark brown. Venation: Sc_1 ending a short distance before the origin of *Rs; m-cu* a short distance before the fork of *M*. Abdominal tergites obscure yellow, margined laterally and caudally with brownish black, the median line of the segments a little dusky; sternites more uniformly yellowish. Male hypopygium with the basistyles terminating in a fleshy lobe and a single, conspicuous, broad-based spine. Dististyle single, broadly oval, terminating in two conspicuous setæ, and bearing a very large, elongate, conical spine, as well as a smaller, pale, slender spine, these latter unequal in size on the dististyles of the two sides of the unique type. Long arms of the gonapophyses likewise asymmetrical, one being much shorter and nearly straight, the other sinuous, the acute apex more narrowly blackened.

Holotype, ♂, Santa Lucia, Chiapas, altitude 575 meters, July 29, 1926 (A. M. Dampf); M. F. 1,055.

Erioptera Meigen.

Erioptera (Mesocyphona) **quadrifurcata** sp. n.

Male. Length about 2.1–2.3 mm.; wing, 2.2–2.5 mm.

Most closely related to *E.* (*M.*) *troglodyta* Edwards (Trinidad), differing especially in the dark coloration, the different leg-pattern and the structure of the male hypopygium.

Rostrum and palpi brownish black. Antennal flagellum pale brown or yellowish brown. Head dark brown, the anterior region of the vertex brighter. Mesonotum dark brown, without evident stripes; scutellum a little paler. Pleura dark brown, with a broad silvery yellow stripe extending from behind the fore coxæ to the base of the abdomen, the dorso-pleural region usually dark. Halteres with yellowish knobs. Legs with the coxæ dark; trochanters obscure testaceous; femora yellow with two dark annuli, most conspicuous on the posterior femora, the subterminal ring a little darker in color than the medial ring; on the fore legs the coloration is more infumed, with only the subterminal ring; tibiæ and tarsi yellow. Wings short and broad, with a faint brownish tinge, immaculate; veins and macrotrichiæ darker. Abdomen, including the hypopygium, dark brown. Male hypopygium with the dististyle single, with four free points, the outer being a slender, dark-colored rod, the inner a long pale rod, the main body of the style being produced into a stout curved arm that is split at apex into two parts, the outer a broad, flattened, curved black portion, the margin microscopically serrulate, the second point slender, much longer, pale in color. Gonapophyses appearing as long, gently curved black horns, the tips acute.

Habitat: Mexico, Salvador. *Holotype*, ♂, Rancho Sabino Perez, Chiapas, Mexico, altitude nearly 500 meters, hilly country with bush and forest, with small rivulets, at light, July 28, 1926 (A. M. Dampf); M. F. 1,052. *Allotype*, ♀, San Isabel, Chiapas, altitude about 650 meters, typical pine ridge vegetation, near swift-flowing brook, at light, July 30, 1926 (A. M. Dampf); M. F. 1,057. *Paratypes*, ♂ ♀, with the allotype; 1 ♂, Agronomia, Sonsonate, Salvador, altitude 1,500 feet, March 20, 1926 (K. A. Salman).

Cryptolabis Osten Sacken.

Cryptolabis (Cryptolabis) **fuscovenosa** sp. n.

Head obscure yellow, the central third dark brown; mesonotal praescutum with three velvety-black stripes; pleura black, striped longitudinally with yellowish white; femora yellowish brown, the tips blackened; wings whitish with conspicuous grayish brown seams on certain of the veins; macrotrichiæ of the cells sparse, including cells R_5 to M_2.

Female. Length about 3.6 mm.; wing, 4.2 mm.

Rostrum and palpi black. Antennæ black throughout, short, the flagellar segments oval. Head obscure yellow, the central third of the vertex and occiput dark brown.

Pronotum whitish yellow. Mesonotal praescutum virtually covered by three velvety-black stripes, the interspaces very narrow, paler brown; humeral region orange-yellow; lateral margins of praescutum narrowly yellowish, margined internally by the black lateral stripes;

scutum pale brown medially, the lobes black; scutellum obscure yellow, darker basally and laterally; postnotum black, the extreme cephalic lateral angles yellowish white. Pleura black, striped longitudinally with pale yellowish white, the dorsal stripe including the dorso-pleural region, passing beneath the wing-root, across the dorsal portion of the pleurotergite to the mediotergite; ventral stripe narrow, traversing the sternopleurite; a small spot before the root of the halteres. Halteres pale. Legs with the coxæ and trochanters obscure yellow; femora yellowish brown, the tips rather narrowly but conspicuously blackened; tibiæ obscure yellow, the tips narrowly blackened; basitarsi yellowish brown, the distal half and the remainder of the tarsi brownish black. Wings whitish, with conspicuous grayish brown seams along several of the veins, including the anterior cord; R_2 and adjoining veins; broader washes along veins R_5, M_3, M_4, Cu_1 and *m-cu;* axilla conspicuously darkened; veins dark brown, costa paler. Macrotrichiae of cells very sparse, there being none in cell R_3, a few in outer end of cell R_4; rows of trichiæ in the distal half of each of cells R_5 and M_2. Venation: *Sc* short, Sc_1 ending before the fork of *Rs*, Sc_2 far before the origin of *Rs; Rs* strongly convex; R_2 a little longer than R_{2+3}, the two nearly in transverse alignment; cells beyond the cord deep.

Abdomen dark brown, the genital segment paler.

Holotype, ♀, Rio Mayo, near Navojoa, Sonora, March 25, 1927 (A. M. Dampf); M. F. 1,221.

TWO NEW NOTONECTA FROM SOUTH AMERICA. (Hemiptera-Notonectidæ).

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Through the kindness of Mr. R. B. Vereertbrugghen I have received the new back-swimmers described below. There were two species of Notonecta in the lot—one very much resembling the larger species common in Chile and the smaller one so much like the smaller Chilean species that I thought that both species were the same as those sent to me by Mr. Alfredo Faz from Santiago, Chile—closer study shows them to be species distinct from any hitherto described.

Notonecta vereertbruggheni sp. new.

Size: Length 11 to 12 mm.; width of head 2.9 mm.; width at rear of prothorax 4.2 mm.

Color: General facies dark—typical coloring as follows: Head and anterior half of pronotum, and limbs yellow, the last named often somewhat clouded. Posterior half of pronotum darkened by the black mesothorax beneath, scutellum black; Hemelytra black streaked with tan. Clavus with longitudinal streak of tan, corium with a longitudinal pale stripe that is often obliterated in the middle leaving tan spots on base and distal field. Membrane black. Venter black save margin of abdomen.

Structural characteristics: Head depressed, eyes not prominent, divergent. Interocular space at synthlipsis about two-thirds the width of an eye. Vertex- synthlipsis : : 3:2. Thorax arched, mesotrochanter rounded. The male genital capsule is long and slender without keel or digitate process, posterior lobes long and slender and clasper parallel sided with anterior distal end prolonged and slightly hook shaped.

Described from 15 males and 11 females taken by Dr. Vereertbrugghen in whose honor the species is named. They are taken in Rio Negro territory of Argentina, South America. Holotype, allotype and paratypes in Kansas University collection. Some Paratypes also in U. S. N. Museum at Washington D. C.

Notonecta bicircoidea sp. new.

Size: 9 mm. long; width of head 2.4 mm.; width at rear of prothorax 3.2 mm.

Color: General facies quite like *Notonecta bicirca* Hungerford but darker. The elongate yellow spot on lateral margins of scutellum which is present in *Notonecta bicirca* is nearly always absent in this species. Hemelytral suture and tip of clavus black.

Structural characteristics: Head slightly less prominent than that of *Notonecta bicirca* and synthlipsis a trifle narrower. The genital capsule of the male is much larger (4:3) although the insects are the same in size. The clasper is broader and more curved than in *Notonecta bicirca.*

Described from fourteen specimens—four males and ten females, taken in Rio Negro territory, Argentina. Figures of the above described species will appear in a paper which deals more fully with the South American members of the Genus Notonecta.

SEASONAL ABUNDANCE AND VERTICAL MIGRATIONS OF LUCILIA CAESAR LINN. AND OTHER INSECTS IN AN ARTIFICIAL GROVE*

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During the spring of 1922, working under the direction of Dr. C. L. Metcalf, I undertook the study of certain insects common in the forestry plot on the campus of the University of Illinois. This grove of trees, comprising about twenty acres of land, was planted in 1871, and contained samples of trees of various kinds, planted in rows, and spaced several yards apart. The undergrowth in the plot was mowed each year, and the grove was kept much as a park might be. On the east and north it was bordered by the residence section of the city and on the west and south by the ornamental gardens and experimental fields of the University farm. The whole neighborhood was kept reasonably free from all garbage and carrion which might serve as breeding places for flies, with the possible exception of the manure used as fertilizer on the campus farms and gardens.

In this grove several species of insects were collected in fly traps during the season and an attempt was made to correlate their distribution with data regarding environmental conditions.

APPARATUS AND METHODS.

Three ordinary wire-screen fly traps were maintained near the center of the forestry, one being placed on a wooden box on the ground, another suspended from a rope at a height of 25 feet above the ground, and a third suspended from the same rope at a height of 50 feet and well into the tree-tops. Each trap was provided with a bait can, containing a piece of burlap soaked in a mixture of molasses and fermenting banana, renewed once a week. Collections from these traps gave evidence of vertical migrations of species to and from the tree-tops. Similar migrations at lower levels have been reported by

* Contribution from the Entomological Laboratories of the University of Illinois, No. 115.

Sanders and Shelford (1922) and by Weese (1924) but very little study has been devoted to the tree-top levels.

On a separate rope two atmometers were suspended, one at the 25 foot level and another at 50 feet. A third was placed at the ground level. All were arranged in protective cages and attached in such a way that they could be inverted every few days to guard against any bubbles of air which might collect in the atmometer cups. This did not happen so far as known. The atmometers were removed and standardized once during the summer and again in the fall and all readings corrected accordingly.

On the ground beneath the cages was placed a small house with wire-screen sides for storage of instruments, nets, etc. It also contained a hygro-thermograph, to furnish data on temperature and humidity at this level. Accurate means of determining these factors at the higher levels were not available.

Additional data were obtained from the weather-record office at the University (one-half mile distant), representing conditions outside the forestry at the time of the collections. These included information regarding sunshine, temperature, rainfall, humidity, wind and barometric pressure. Environmental data from the above mentioned sources are summarized in Plate VII.

The apparatus was visited twice a week or more throughout the season. On Monday mornings at 8 A. M. the hygro-thermograph chart was changed and everything looked over superficially to guard against accidents. On Friday mornings the traps were emptied and rebaited and atmometer readings were taken by refilling the jars from a graduate of distilled water. In emptying a trap, the apparatus was placed upside down on the ground, the insects jarred down in it, and the wire-cone quickly removed and replaced by a cloth to cover the opening. Then an insect net was carefully slipped over the mouth of the trap to replace the cloth, and the whole cage swung back and forth in the air to drive as many flies as possible into the net. This was repeated several times and the remaining stragglers, the beetles, etc., removed from the trap with a small cyanide bottle. Collections were carried to the laboratory in cyanide bottles and then transferred to pasteboard boxes for storage until assorted and counted. Some of the collections contained enormous numbers of insects, and of these only a few

easily determined species have so far been studied. The entire series of collections was sorted over for these species and the counts were checked each time a new species was separated out.

TABLE I. COLLECTIONS OF INSECTS IN THE TRAPS.

Species	Lucilia Caesar			Psilophis sipho			Pseudotephritis vau			Chrysopa plorabunda		
Station	1 ft.	25 ft.	50 ft.	1 ft.	25 ft.	50 ft.	1 ft.	25 ft.	50 ft.	1 ft.	25 ft.	50 ft.
Date												
4–17	4	10	1	....	....	....	16	0	0	....	....	....
4–22	36	0	0	....	....	....	0	0	0	....	....	....
4–29	22	0	0	....	....	....	0	0	0	....	....	....
5–6	56	73	23	....	....	....	1	5	0	....	....	....
5–12	2252	300	262	....	....	....	47	24	1	....	....	....
5–19	91	39	28	....	....	....	0	1	3	....	....	....
5–26	448	30	47	1	0	0	0	1	0	....	....	....
6–2	2787	1498	177	0	1	5	61	31	18	....	....	....
6–9	43	12	12	9	2	19	4	9	18	....	....	....
6–15	330	81	29	209	36	88	7	93	41	....	....	....
6–23	103	88	29	100	12	219	11	75	204	0	0	1
7–1	35	64	160	30	3	39	6	0	0	2	0	0
7–7	645	288	283	5	3	44	10	42	77	0	0	0
7–14	185	94	202	1	2	7	0	21	22	1	0	0
7–21	360	355	131	1	2	15	1	42	34	0	0	2
7–28	242	328	22	3	0	11	1	19	5	0	1	0
8–4	389	187	14	2	1	6	0	24	7	0	1	0
8–10	209	264	18	0	1	3	0	0	0	0	1	0
8–19	420	420	26	0	0	1	....	....	....	0	0	0
8–25	646	268	20	1	0	0	....	....	....	0	1	0
9–2	304	368	10	....	....	....	....	....	....	0	0	0
9–8	212	117	4	....	....	....	....	....	....	0	1	0
9–15	50	63	1	....	....	....	....	....	....	0	1	0
9–22	49	13	19	....	....	....	....	....	....	0	0	0
10–1	371	7	79	....	....	....	....	....	....	0	0	2
10–9	289	95	116	....	....	....	....	....	....	0	10	0
10–13	94	5	10	....	....	....	....	....	....	0	0	0
10–20	1140	12	37	....	....	....	....	....	....	0	0	0
10–27	417	19	28	....	....	....	....	....	....	3	1	1
11–3	418	35	49	....	....	....	....	....	....	3	7	1
11–10	135	6	6	....	....	....	....	....	....	5	4	0
11–17	78	3	1	....	....	....	....	....	....	4	1	0
11–24	13	0	0	....	....	....	....	....	....	0	0	0
12–8	6	0	1	....	....	....	....	....	....	1	0	0

Specimens of each species were submitted to specialists for determination. Table I and Plate VI show the seasonal abundance of species studied.

Lucillia caesar Linn.

Plate VI, E, and Table I show the seasonal abundance of the green bottle fly, in each of the three traps. The traps were in the field as early as April 2nd but the first specimen of *Lucilia caesar* was observed in the ground trap on April 13th, and from this date until December 8th the species was always represented in the collections in varying numbers. The highest number caught in one trap was taken during the week ending June 2nd, in the bottom trap, and represented a total of 2,787 specimens from one trap. Another large collection was taken a few weeks previous to this on May 12th, and another occurred late in the season on October 20th. The size of these collections may have been correlated with the temporary presence of large manure-heaps on the nearby farm lands. Data on this point were not available. The seasonal curve for *Lucilia caesar* shows about nine distinct modes during the year. The distance between any two consecutive modes represents in general a period of two or three weeks, as indicated on Plate VI. These periods of abundance of flies might be due to environmental factors or to the occurrence of distinct generations. Careful analysis of the available data does not give a satisfactory explanation on the basis of environment, although unknown factors may have been effective. The fact that similar modes sometimes occur in the distribution curves of other species on the same dates indicates strongly that environment at least tended to increase the numbers present. However it seems likely that the varying abundance can be explained better by assuming the modes of the curve represent successive generations of insects. Herms (1907) estimated the period from egg to adult in *Lucilia caesar* at 15-17 days, and adds to this a period of 9 days before the adult oviposits, making a total of 27 days from one generation to another. These estimates make it seem likely that the modes on the seasonal distribution curve represent nine generations of the fly during the season, accentuated probably by environmental factors.

Attempts to correlate other features of the abundance of *Lucilia caesar* with environment met with some success. A glance at curves E in Plate VI indicates that the largest collections occurred in the spring and fall, and this is perhaps correlated with unsettled weather at these seasons as shown in

Plate VII. In this plate it is seen that the curves for various factors show more irregularities at the two ends of the season than during the summer. Apparently unsettled weather and especially changes in barometric pressure and low temperature in the spring and fall caused the insects to seek shelter in the forest plot. The first frost occurred October 13th, and was followed by a large collection in the forest. Weese (1924) has shown a similar tendency in other insects to migrate into the forest in the fall to seek shelter and hibernation quarters.

Further study of the environmental data shows the following correlations—The large collection of May 12th was separated from that of June 2nd by a period of rainfall. The large collection of June 2nd was correlated with high evaporating power of the air and moderate wind, and followed a period of low pressure. In this connection Parman (1920) states that flies tend to emerge during periods of rising barometer. Rather large collections of July 7th, August 25th and October 1st are correlated with low humidity and followed by rain, and the larger collection of October 20th occurred during low humidity, low temperature and just after the first frost.

In general large collections followed periods of low daily variation in barometric pressure, a fact which is in agreement with the work of Parman (1920) on the effect of barometric pressure on muscoid diptera. Parman states that flies are more numerous during periods of steady barometric pressure.

An unusually low collection of *Lucilia caesar* was made during the latter part of September, as shown in the curve. This may mean that the flies were distributed more evenly over the country or it may mean that many species were killed off by some factor. Study of the data on environment shows that this period accompanied a period of unusually high pressure. This may have been the destructive factor. Parman (1920) states that on a rapidly falling barometer several species of flies go into a state of coma, in which condition they are subject to the action of destructive agencies such as disease, etc. No data on disease or parasites were available in the present investigation. This period of lesser abundance of flies was also correlated with a falling temperature.

Lucilia caesar showed some tendency to migrate to the tree-tops during the early part of July, the largest tree-top collection of the species being taken July 7th. The reason for

this migration is not known. Very few specimens of *Lucilia caesar* were taken in the tree-tops during the months of August and September, probably correlated with the fact that there was very little high wind during these months. Presumably high wind caused the flies to seek shelter among the leaves, and low wind enabled them to fly in the leafless regions about the trunks of the trees below.

TABLE II. EVAPORATION DATA FROM CORRECTED ATMOMETER READINGS.

Date	Ground Level	25-Ft Level	50-Ft. Level
May 6	.....	68 cc.	70 cc.
May 13	.....	133	.....
May 23	.....	47	.....
June 2	193	203	168
June 9	60	81	90
June 15	89	105	112
June 23	166	140	143
July 1	123	99	117
July 10	137	.....	.....
(Records interrupted accidentally. Atmometers standardized).			
July 27	130	107	145
August 4	102	99	105
August 10	110	117	120
August 18	156	148	166
August 25	73	84	92
September 2	116	138	140
September 8	84	123	123
September 16	105	139	121
September 22	123	101	113
September 28	155	202	172
(Atmometers removed from field and again standardized).			

Psilopus sipho Say.

Curve C, of Plate VI, and Table I show the seasonal abundance of this fly, which was found in the collections from May 26th to August 25th. The most interesting feature with regard to it was the migration which took place during the week of June 15th to 23rd, when the flies moved from the ground level to the tree-tops. Records show that this was the time when the weeds in the vicinity of the traps were being mowed. Atmometer records, given in Table II show that the migration was correlated with a change in the evaporating power of the air caused by this mowing. During the week ending June 15th,

the lowest evaporation was recorded from the ground level, being 89 cc. as against 105 cc. at the 25 foot level and 112 cc. in the tree-tops. The next week after the mowing of the weeds the relative conditions were reversed, the figures being 166 cc. near the ground, 140 cc. at 25 feet and 143 cc at 50 feet. *Psilopus* thus seems to have migrated toward a region of low evaporation, which is not surprising in view of the well known reactions of animals in gradients of this factor as shown by Shelford (1913). In this case the species probably chose the 50 foot level instead of the 25 foot level on account of protection from wind among the leaves. Records also show that the humidity at the ground level was lowered and made more variable due to the mowing, and these factors may have been effective.

Pseudotephritis vau Say.

This species of picture-wing fly occurred in the collections from April 17th to August 4th, (See Plate VI B). Like *Psilopus* it migrated following the mowing of the weeds, in this case from the 25 foot level to the tree-tops, a fact not so well explained by the available data, unless it sought protection from wind among the leaves.

Chrysomyia macellaria Fabr.

The screw-worm fly was taken only late in the summer and chiefly from the ground trap, as shown in Plate VI D. Only one was taken in the tree-tops and a few at the 25 foot level.

Chrysopa plorabunda Fitch.

Chrysopa did not appear in the collections until June 23rd, as shown in Table I. It showed some tendency to stay in the upper levels through the summer, but in October and November was more abundant near the ground, a reaction perhaps correlated with unsettled weather.

MISCELLANEOUS SPECIES.

Some Carabid, Elaterid and Silphid beetles were noted in the collections from the ground trap, being taken in higher traps only very rarely. Phalangids were attracted to the ground trap during the latter part of June and early July. Syrphid

flies were numerous in the collections and will be reported on in a later paper. A cursory examination revealed some supposedly rare species of this group in the tree-top collections.

CONCLUSIONS.

Insects were trapped at different levels in a forestry plot and an attempt made to correlate their distribution with the environmental factors.

1. *Lucilia caesar* Linn. occurred in some abundance from April 13th, to December 8th, showing indications of about nine broods during the season. It was more abundant near the ground than in the tree-tops, and occurred in larger numbers in the spring and fall than during midsummer. In general the species was more abundant during periods of dry, warm weather with a high percentage of sunshine, steady barometer and moderate wind.

2. *Psilopus sipho* Say, migrated from the ground to the tree-tops in response to a change in the evaporating power of the air, and other factors produced by a mowing of the weeds in the forest plot.

3. *Pseudotephritis vau* Say, migrated from the 25 foot level to the tree-tops, after the mowing of the weeds.

4. *Chrysopa plorabunda* Fitch, migrated toward the ground during October and November.

ACKNOWLEDGMENTS.

The author is indebted to Dr. C. L. Metcalf under whose guidance the paper was begun and completed.

The insects studied were identified by the following specialists: Dr. Alexander MacGillivray (Lucilia); Dr. C. L. Metcalf (Syrphidæ); Dr. C. P. Alexander (Chrysomyia); Dr. R. C. Smith (Chrysopa); Dr. M. C. VanDuzee (Psilopus); and Dr. J. R. Malloch (Pseudotephritis).

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EXPLANATION OF PLATES.

PLATE VI.

SEASONAL OCCURRENCE OF INSECTS STUDIED.

Dates are given on the horizontal scale below. Lines represent the numbers of insects of various species taken in the traps through the season. Catches from the ground level are designated by full lines, catches from the 25-foot level by broken lines, and catches from the 50-foot level by dotted lines. Species shown are as follows: *B. Pseudotephritis vau* Say, *C. Psilopus sipho* Say, *D. Chrysomyia macellaria* Fabr. and *E. Lucilia caesar* Linn.

PLATE VII.

DATA ON ENVIRONMENTAL FACTORS.

All records are averaged for periods of approximately a week in length, corresponding to exact dates of emptying traps. Dates are given on the horizontal scale below. Lines represent changes in environmental factors during the season, as follows:

A. Evaporating power of the air, from data taken in the field, by porous-cup atmometers. Full line represents the ground level, broken line the 25-foot level, dotted line the 50-foot level.

B. Occurrence of high winds. From data obtained from the University weather-record office. Curve shows per cent of wind records of 15 miles per hour or more, based on three observations per day.

C. Mean daily variation in Barometric pressure, data from the weather-record office, three readings per day.

D. Mean Barometric pressure. Data from weather-record office, three readings per day.

E. Precipitation, summarized in approximately weekly periods. Data from weather-record office.

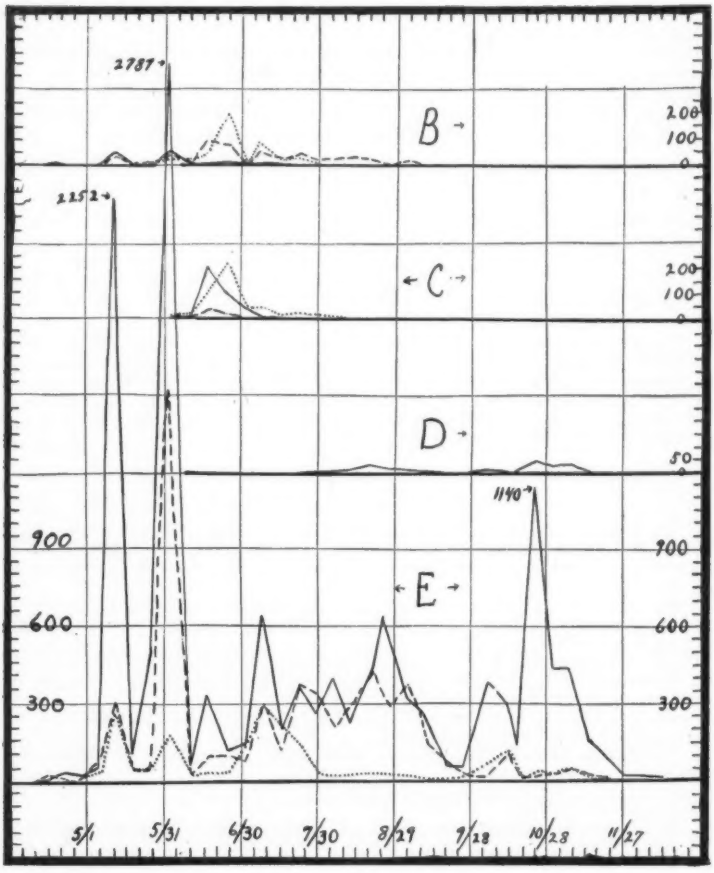
F. Mean daily variation in humidity. Data from hygro-thermograph in the forestry. Two-hour periods on the sheets were estimated and the daily variation of these values computed and averaged for the week.

G. Mean Humidity. From the Hygro-thermograph. Average of all the two-hour periods during the week.

H. Mean daily variation in temperature. Computed same as F.

I. Mean Temperature. Computed same as G.

J. Per cent of sunshine. Data from the weather-record office. Three observations per day. Curve represents per cent of "Fair" observations during the week.


2787
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11/27

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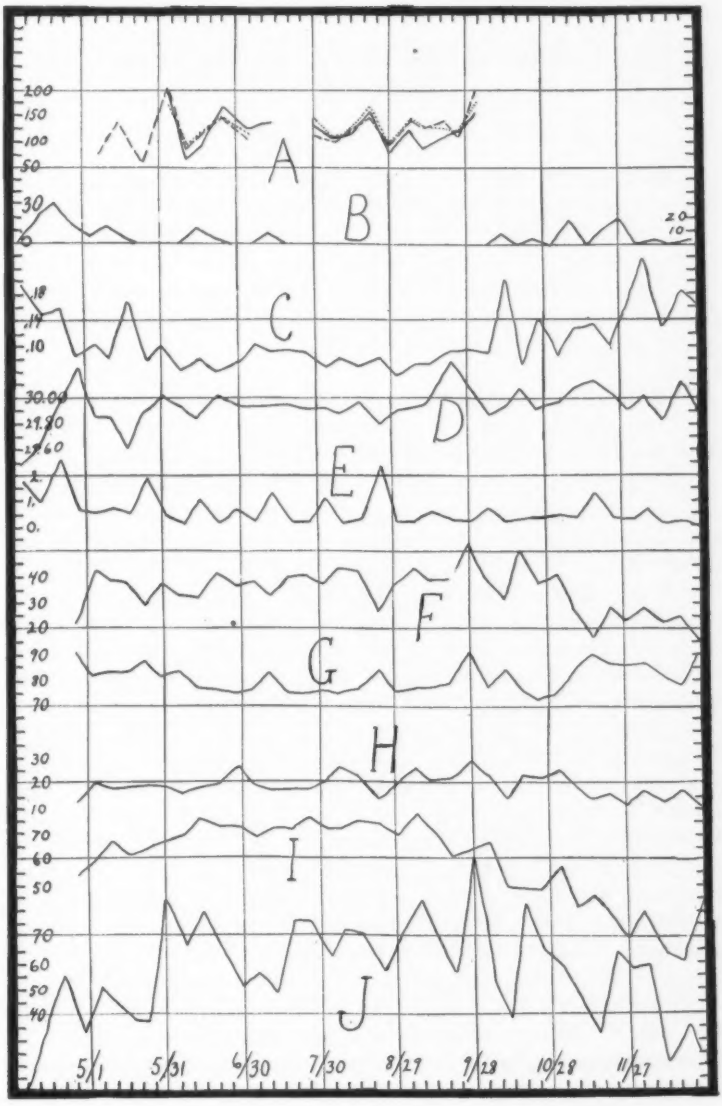
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9/28
10/28
11/27

M. T. Townsend

SOME NOTES ON THE INSECT FAUNA OF AN IOWA PRAIRIE.*

GEORGE O. HENDRICKSON.

The original prairie of Iowa has nearly disappeared. The few remaining tracts will be preserved for many years because of general interest in the native conditions of the state. A large number of prairie insects have been described, and reported. Since the life histories, habits, and hosts of only a few have been recorded, it was thought that a study of the insect fauna of a prairie area would be of general interest, and value.

The collections and observations were made at a five acre tract of original prairie located three miles northwest of Ames. The prairie is in the possession of Doctor Ada Hayden, of the Department of Botany, Iowa State College. Doctor Hayden has classified this preserve as a *Stipa-Bouteloua* Formation, and has discussed the plant distribution in "Notes on the Floristic Features of a Prairie Province in Iowa" appearing in the Proceedings of the Iowa Academy of Science for 1918.

The writer is deeply indebted to the following for determinations of species: Prof. J. E. Guthrie, Iowa State College, in *Collembola;* Dr. B. B. Fulton, Iowa State College, in *Orthoptera;* Prof. J. Douglas Hood, Univ. of Rochester, in *Thysanoptera;* Prof. D. M. DeLong, Ohio State Univ., Dr. E. D. Ball, Sanford, Fla., Mr. Wm. T. Davis, Staten Island, N. Y., in *Homoptera;* Dr. H. H. Knight, Dr. C. J. Drake, Prof. H. M. Harris, Iowa State College, Mr. H. C. Barber, Roselle, N. J., in *Hemiptera;* Prof. H. F. Wickham, Univ. of Iowa, in *Coleoptera;* Dr. Annette F. Braun, Cincinnati, Ohio, Dr. H. G. Dyar, National Museum, Dr. W. T. M. Forbes, Cornell Univ., in *Lepidoptera;* Prof. J. S. Hine, Ohio State Univ., Prof. H. J. Reinhard, Texas Agric. Exper. Station, Prof. C. L. Fluke, Univ. of Wisconsin, in *Diptera;* Miss Grace Sandhouse, Messrs. A. B. Gahan, R. A. Cushman, S. A. Rohwer, National Museum, Dr. M. R. Smith, Mississippi Agric. and Mech. College, in *Hymenoptera.*

*Contribution from Department of Zoology and Entomology, Iowa State College.

An annotated list of common insects, and scarce insects, probably less numerous elsewhere, follows. These species are considered typical of this ecological formation.

Order *Collembola.*

Lepidocyrtus purpureus Lubbock. August 14, 1926. Taken on ground among light debris.

Aphorura ambulans L. August 16, 1926. Found under stones.

Order *Orthoptera.*

Diapheromera veliei Walsh. July 6–August 15, 1925; June 6–August 16, 1926. At first of season all adults were green. Red female taken August 16, and several seen with red streaks. Taken more frequently in taller grass.

Eritettix simplex Scudd. April 21–June 25, 1926. Most active May 28.

Orphulella speciosa Scudd. July 15–August 24, 1925; July 11–October 1, 1926. Taken in largest numbers in shortest grasses. Most numerous of *Orthoptera* in the field.

Chortophaga viridifasciata De Geer. April 21–May 28, 1926. Most numerous during first week in May. First three specimens taken are brownish males; greenish specimens, female, first taken May 1.

Encoptolophus sordidus Burm. August 10–22, 1925; August 7–October 1, 1926. Most numerous among short *Bouteloua.*

Hippiscus apiculatus Harr. May 15–June 4, 1926. Scarce.

Pseudopomala brachyptera Scudd. June 23–August 21, 1925; August 2–25, 1926. All of short-winged form. Taken in taller grasses.

Melanoplus confusus Scudd. June 16–July 21, 1925; May 3–August 14, 1926. Mating pairs taken June 19-22, 1926. This species was first of the genus to reach adult stage in 1926.

Melanoplus dawsoni Scudd. July 15–August 24, 1925; June 24–October 9, 1926. Most numerous in short grass.

Melanoplus femur-rubrum De Geer. July 21–August 24, 1925; August 13, 1926.

Melanoplus keeleri-luridus Dodge. June 23–August 24, 1925; July 30–October 9, 1926. Most abundant *Melanoplus* of this tract.

Phoetaliotes nebrascencis Thom. August 15–October 9, 1926. More numerous in taller grass.

Neoconocephalus ensiger Harr. August 3-21, 1925; August 7-16, 1926. Several pinkish females taken after *Andropogon* grasses had reddened.

Orchelimum vulgare Harr. August 3-24, 1925. None seen in 1926.

Conocephalus strictus Scudd. August 5-24, 1925; August 13, 1926. Males far outnumbered females.

Nemobius fasciatus De Geer. August 18, 1925; August 13–October 9, 1926. All of short-winged form.

Oecanthus quadripunctatus Beut. August 3-24, 1925; August 2-14, 1926. More common in taller grass.

Order *Thysanoptera.*

Aelothrips fasciatus L. May 17, 1926. Taken in flower of wild strawberry.

Frankliniella tritici Fitch. April 11-19, 1926. Taken in flowers of pasque flower (*Anemone patens* var. *Wolfgangiana* Koch).

Order *Hemiptera.*

Homaemus bijugis Uhl. June 18–September 17, 1926.

Homaemus parvulus Germ. June 29, 1926.

Euschistus variolarius P. B. June 20–August 24, 1925; June 4–October 9, 1926.

Amnestus spinifrons Say. October 9, 1926.

Amnestus pallidus Zimmer. October 9, 1926.

Coenius delius Say. July 2, 1925; May 26–October 1, 1926.

Alydus conspersus Montd. July 28–August 15, 1925; June 4–September 17, 1926. Reared on ground plum (*Astragalus caryocarpus* Ker.).

Alydus eurinus Say. August 13, 14, 1926.

Nysius ericæ Schill. June 19–August 7, 1926. Several came to light, night of August 3.

Ligyrocoris diffusus Uhl. June 20–August 24, 1925; June 19–October 1, 1926.

Piesma cinerea Say. May 9–October 9, 1926.

Melanorhopala clavata Stal. July 8-28, 1925; June 8, 1926.

Phymata erosa fasciata Gray. July 8–August 3, 1925; July 14–September 17, 1926. Found most numerous on flowers visited by most of other insects upon which they prey, irrespective of coloration of flower.

Nabis ferus Linn. June 20–August 24, 1925; March 23–October 9, 1926.

Triphleps insidiosus Say. July 15, 1925; August 13–October 9, 1926.

Adelphocoris rapidus Say. June 20–August 24, 1925; May 28–October 1, 1926.

Lygus pratensis oblineatus Say. June 20–August 24, 1925; March 23–October 9, 1926.

Lopidea minor Knight. June 20–August 19, 1925; June 24–August 25, 1926. Showed preference for *Petalostemum purpureum* Rybd.

Lopidea teton Knight. June 18-20, 1925; May 26–June 5, 1926. Two reared from last instar on ground plum (*Astragalus caryocarpus* Ker.). Observed feeding on fruit of ground plum, fruit shrivelled.

Chlamydatus associatus Uhl. July 2–August 18, 1925; May 9–August 25, 1926.

Plagiognathus davisi Knight. July 14, 1926. Known previously from type locality, New Jersey, only.

Order *Homoptera.*

Okanagana balli Davis. June 18, 1925; June 8-28, 1926. Female came to singing male, fluttered wings with muffled sound, and male followed female while both crawled over vegetation.

Melampsalta calliope Walk. June 2, 1925; July 2, 1926. Scarce.
Stictocephala inermis Walk. July 27, 1925; July 7–August 25, 1926.
Campylenchia latipes Say. June 20–August 24, 1925; June 28–October 9, 1926.
Agallia sanguinolenta Prov. July 2–August 3, 1925; June 19–October 1, 1926.
Draeculacephala mollipes Say. June 25–August 24, 1925; June 19–October 9, 1926.
Gypona melanota Spangb. July 21–August 21, 1925; August 13-25, 1926.
Platymetopius cinereus O. and B. June 20–August 21, 1925; June 19–August 18, 1926.
Deltocephalus albidus O. and B. June 25–July 28, 1925; July 7–August 18, 1926.
Deltocephalus inimicus Say. June 18–August 21, 1925; June 19–October 9, 1926.
Deltocephalus abbreviatus O. and B. August 15, 1925. Scarce. On short *Bouteloua* grass.
Deltocephalus minimus O. and B. August 18, 1926. Scarce.
Deltocephalus oculatus O. and B. June 4, October 1, 1926. Scarce.
Deltocephalus unicoloratus O. and B. June 18–August 5, 1925; June 19–August 18, 1926.
Euscelis striatulus Fall. June 18–August 24, 1925; June 19–September 17, 1926. Most numerous member of *Homoptera*.
Euscelis comma Van D. June 20–July 28, 1925; June 19–July 30, 1926.
Euscelis curtisii Fh. July 2–August 24, 1925; July 7–August 16, 1926.
Euscelis anthracinus Van D. August 25, 1926.
Chlorotettix spatulatus O and B. July 27–August 23, 1925; August 18, 1926.
Phlepsius irroratus Say. August 18–October 9, 1926.
Cicadula sexnotata Fall. June 25–August 5, 1925; August 3–September 24, 1926.
Scolops sulcipes Say. June 20–August 24, 1925; July 6–August 13, 1926. Common.
Scolops desiccatus Uhl. August 21, 1925. Scarce.

Order *Coleoptera*.

Cicindela punctulata Fabr. August 2 1925; August 3-9, 1926. Taken on ground in shortest grass.
Stenolophus conjunctus Say. March 23–May 1, October 9, 1926.
Hippodamia parenthesis Say. May 12–October 1, 1926. Most numerous June 15.
Hippodamia convergens Guer. August 24, 1925; June 8–October 9, 1926. Most numerous July 14, 1926.
Languria mozardi Latr. July 30–August 13, 1925; May 3-17, October 9, 1926. Larvæ were borers in flowering stalks of purple coneflower (*Brauneria purpurea* Britton).
Acmaeodera pulchella Herbst. June 23-30, 1925; June 28–July 14, 1926. Taken on flowers of several *Compositæ*.
Ditemnus bidentatus Say. August 5, 1925; May 9-12, August 18, 1926.

Chauliognothus pennsylvanicus De G. August 18–October 1, 1926.
Collops quadrimaculatus Fabr. July 27, 1925; May 30–August 16, 1926.
Hydnocera tricondylæ Lec. June 25–August 10, 1925; August 1–August 16, 1926. Most numerous and active insect in the field August 1, 1926. Several were feeding on leaves of purple coneflower (*Brauneria purpurea* Britton).
Anomala innuba Fabr. June 18-20, 1925; June 4-24, 1926. Most numerous June 19, 1926.
Strigoderma arboricola Fabr. June 18-30, 1925; June 15–July 26, 1926. Taken from wild rose, and flowers of lead plant (*Amorpha canescens* Pursh.).
Typocerus sinuatus Newm. June 25-30, 1925; June 30–July 14, 1926. Most numerous on flowers of *Coreopsis palmata* Nutt.
Anomoea laticlavia Forst. June 18-20, 1925; June 18, 1926.
Babia quadriguttata Oliv. May 31–June 28, 1926. Several seen to feed on leaves of lead plant (*Amorpha canescens* Pursh.).
Nodonota puncticollis Say. June 18, 1925; May 31–June 19, 1926. On June 19, 1926 many were feeding on leaves of *Amorpha canescens* Pursh.
Trirhabda canadensis Kirby. June 23–July 21, 1925; July 2–August 25, 1926.
Galerucella americana Fabr. June 20–July 15, 1925; April 28–June 28, 1926. Common on leaves of sunflowers (*Helianthus* spp.).
Diabrotica 12-punctata Fabr. August 3-13, 1925; June 7, August 5–October 9, 1926. Common on flowers of *Compositæ*, chiefly.
Diabrotica longicornis Say. August 15, 16, 1925; August 25–October 9, 1926. Common on flowers of *Compositæ*, chiefly.
Disonycha triangularis Say. March 21–May 21, August 13, 1926.
Longitarsus testaceous Lec. July 2, 1925; April 12–May 17, 1926. One seen to feed on leaf of purple coneflower (*Brauneria purpurea* Britton).
Luperaltica fuscula Lec. July 28–August 24, 1925; August 16-25, 1926. Mating pairs numerous August 25, 1926.
Chaetocnema denticulata Ill. June 20–July 28, 1925.
Psylliodes punctulata Melsh. March 22–May 9, 1926.
Microrhopala vittata Fabr. July 2–August 10, 1925; June 6–August 9, 1926. Larvæ are leaf miners of rosin-weed (*Silphium laciniatum* L).
Macrobasis unicolor Kirby. June 27, 1925, May 26, August 25, 1926.
Epicauta pennsylvanicus De Geer. June 25–August 24, 1925; August 25–September 24, 1926.
Rhyncites bicolor Fab. June 18-23, 1925; June 6-22, 1926. Taken on wild rose, only.
Rhyncites niger Boh. June 20–July 2, 1925; June 14–July 14, 1926. Adult gouges stems about three inches below heads of rosin-weed (*Silphium laciniatum* L.) and purple coneflower (*Brauneria purpurea* Britton), and female lays eggs in drooping, withered heads.
Epicaerus imbricatus Say. July 8–August 10, 1925; May 5–August 16, 1926. Observed feeding on leaves of *Lespedeza* sp., and *Amorpha canescens* Pursh., and taken on several others of *Leguminosæ*.

Order *Lepidoptera.*

Cercyonis alope olympus Edw. Collection August 13, 18, 1925. Common throughout summers of 1925 and 1926.

Argynnis idalia Dru. Collection June 20, 1925. Several seen at each visit June 20–August 24, 1925 and June 19–August 25, 1926.

Chrysophanus dione Scud. Collection June 21, 1925; July 2, 1926. Fairly common for several weeks in June and July, 1926.

Pamphila metea Scud. Collection June 23, 1925. Common in June of 1925 and 1926.

Tarachidia tortricina Zell. Collection July 2, 1926. Common in 1926.

Tarachidia candefacta Hbn. Collection May 21, 1926. Common at flowers of golden Alexanders (*Zizia aurea* Koch.) during May and June, 1926.

Catocala whitneyi Dodge. July 24, 1925. Reared from larva taken on goldenrod (*Solidago* sp.).

Lipocosma sicalis Walk. Collection June 24, 1925. Common in June and July, 1925 and 1926.

Argyria argentana Martyz. Collection June 25, 30, 1925. Common in mid-summer, 1925 and 1926.

Homeosoma electellum Hulst. August 26, 1925; August 14, 1926. Reared from larvæ on flowers of blazing star (*Liatris squarrosa* Willd.), and rosin-weed (*Silphium laciniatum* L.). Larvæ seen to feed on flowers of several others of *Compositæ.*

Trichoptilus lobidactylus Fitch. May 30, June 6, 1926. Reared from larvæ working on tops of goldenrods (*Solidago* spp.). Thirty per cent of goldenrod stems were retarded by this species in 1926.

Trichotaphe alacella var? Clem. May 27, 1926. Reared from larva that fed on leaves of false indigo (*Baptisia bracteata* Ell.).

Sparganothis puritana Rob. June 10, 1926. Reared from larva that fed on leaves of lead plant (*Amorpha canescens* Pursh.).

Tortrix pallorana Rob. May 27, 1926. Reared from larva that fed on upper leaves of bastard toad-flax (*Comandra umbellata* Nutt.).

Scythris eboracensis Zell. August 3, 5, 1926. Reared from larvæ feeding on leaves of *Coreopsis palmata* Nutt. Numerous from June to August, 1925 and 1926.

Order *Diptera.*

Psilocephala frontalis Cole. July 8-30, 1925.

Promachus vertebratus Say. July 6, 1925; August 13–September 24, 1926. Observed to lay eggs between achenes of purple coneflower (*Brauneria purpurea* Britton). Maggots left heads to crawl into earth of cages.

Erax aestuans L. June 18–August 3, 1925; June 18–July 30, 1926. Observed to lay eggs between achenes of purple coneflower (*Brauneria purpurea* Britton), June 29–July 26, 1926.

Asilus paropus Walk. June 18–July 30, 1925; June 5-24, 1926.

Dolichopus bifractus Loew. June 25–August 13, 1925.

Mesogramma marginata Say. July 21–August 14, 1925; July 14, 1926.

Limnia saratogensis Fitch. June 20–August 13, 1925.
Ensina humilis Loew. June 19–July 28, 1925.
Euaresta bella Fitch. June 25–July 28, 1925.
Meromyza americana Loew. July 21–August 24, 1925.

Order *Hymenoptera.*

Apanteles harti Vier. July 21–August 24, 1925. One reared from caterpillar that fed on leaves of false indigo (*Baptisia bracteata* Ell.).
Aphaenogaster fulva Roger. August 13, 1925; March 23, 1926. Wingless specimens.
Dorymyrmex pyramicus var. *niger* Per. June 19, 1926.
Tapinoma sessile Say. June 18, 1925; April 3, May 3, 1926.
Prenolepis parvula Mayr. May 17-30, 1926.
Formica fusca var. *subsericea* Say. July 28, 1925; June 4, 1926.
Formica pallide-fulva var. *incerta* Emery. July 15, 1925; June 19, 1926.
Formica pallide-fulva nitidivendris Emery. May 30, 1926.
Formica neogagates lasioides var. *vetula* Whlr. August 21, 24, 1925; May 30, 31, 1926.
Elis quinquecincta Fabr. July 21–August 10, 1925.
Halictus pruinosus Robt. June 23–August 3, 1925.
Halictus albipennis Robt. July 2-29, 1925.
Halictus coreopsis Robt. June 25, 1925.
Bombus pennsylvanicus De Geer. Collection August 21. Common.

HOW INSECTS LIVE, AN ELEMENTARY ENTOMOLOGY, by WALTER HOUSLEY WELLHOUSE; 435 pages, 333 figures. Published by Macmillan and Co.

This volume reflects Professor Wellhouse's experience in teaching beginning entomology. He has found, as have others, that the interest of the beginner is killed by swamping his mind in a mass of details. We teach a student a subject once and then expect him to carry this with him the remainder of his life, but find later that he has retained permanently only a vague view of the subject irregularly illuminated by perhaps a dozen or two of specific facts. Why not in beginning entomology reduce the course to a few forms and study these enough to leave permanent impressions of each? The reviewer seeks this end by having beginning students familiarize themselves only with family groups. Professor Wellhouse has done this by bringing together all the interesting facts concerning one species in each major family. It is correct theory and makes pleasant reading, as even our wife enjoyed it. The interest and the ease of the text remind one of Fabre, while the illustrations are carefully chosen for their specific purposes. The volume is a distinct credit to American entomology and makes one wish that more entomologists could undergo the ameliorating influence of a study of art and literature before entering entomology.—C. H. KENNEDY.

SOME RECENT STUDIES IN AQUATIC HEMIPTERA

(including a new subgenus and a new species)

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In the course of my studies on the taxonomy of the aquatic Hemiptera, there have accumulated a number of observations, some of which I wish to record at this time.

The water bugs are, for the most part, somber colored creatures, possessed of a monotonous uniformity of color and shape within a genus. In many groups, there is a scarcity of obvious specific characters. These facts have always given the taxonomist much trouble. The older authors based their descriptions so largely on color, that in those species where the types are lost or where no holotypes were designated in co-type series containing more than one species, it is almost impossible to make determinations. It would seem that nothing short of thorough revisions with abundant material using structural characters can make possible proper classifications. Excellent progress has been made in recent years. The discovery of genital characters of specific value in the Mesoveliidæ, Gerridæ, Veliidæ, Hydrometridæ, Ochteridæ, Nepidæ, Notonectidæ and Corixidæ has been an aid in these families. The use of the antennæ in the Nepidæ, the stridular areas in the males of the difficult genera Anisops, and Buenoa of the Notonectidæ, and the number and arrangement of the acetabular pits on the Hydrometra is quite recent and satisfactory. There are now a number of splendid workers in the field, giving promise of bringing system out of the present chaotic condition. The splendid work of Dr. T. Jaczewski in Poland, Dr. O. Lundblad in Sweden, Herbert Hale in Australia, and Dr. Tieso Esaki of Japan is proof enough of the above assertion. Mr. J. R. de la Torre Bueno's "Hydrometridæ of the Western Hemisphere" is a careful, clear and creditable contribution to our knowledge of this family of bugs.

It gives one a feeling of gratification to see these clear cut, well-illustrated papers. The longer I work in the taxonomic field, the more firmly convinced I become of the necessity of

illustrations as well as precise descriptions, accompanying proposals of new species. Of course the careful designation, location and preservation of holotypes is now a modern practice and is of the greatest scientific assistance.

Some years ago, in comparing the structural details of *Arctocorixa kennecottii* (Uhler) and *Hesperocorixa brimleyi* Kirkaldy I was struck by the remarkable similarity of these two species. The typical color patterns of these two species are quite different—indeed they are the two most strikingly marked corixids in America. The claval and corial fields of *A. kennecottii* (Uhler) are usually solid black, while the hemelytra of *H. brimleyi* as described by Dr. Kirkaldy are "pale ferruginous, sometimes suffused with sanguineous, base of clavus and a large spot near apex of corium blackish-brown." Indeed the appearance of this last species was such that Dr. Kirkaldy proposed to erect a new sub-genus for it.

The laterally expanded thorax is so characteristic of the insects under discussion that it readily sets them apart from the other American Corixidæ.

An examination of the genital capsules and the male palæ as shown on Plate VIII, Figures 1, 2, 3, and 4, will convince one of the very close affinity if not identity of these species. I have specimens of *A. kennecottii* (Uhler) that have stripes on the pronotum and on the claval and corial fields, also specimens that have the pronotum ferruginous in color and devoid of bars (like *H. brimleyi* Kirkaldy), and one specimen with the black fields of the hemelytra restricted, suggesting the color pattern of Kirkaldy's species.

I should not be surprised to find a series of *A. kennecottii* (Uhler) that graded into typical *H. brimleyi* Kirkaldy. A specimen collected by Mr. Charles H. Martin in Baker County, Georgia, I have named the latter species. It is the only specimen I have seen from a region other than the type locality.

When I received the co-type series of *A. kennecottii* (Uhler) someone had taken the liberty of placing co-type labels on the lot. Whether Dr. Uhler did not recognize the fact that there were two species in the series or whether a later worker confused the material, I do not know. I believe, however, the latter is true. In any case, I found a number of specimens of *A. lucida* Abbott among the co-types of *A. kennecottii* (Uhler). These two species do look somewhat alike, but structurally are

readily distinguished as shown by the drawings on Plate VIII, Figures 4, 6, 7 and 8. Note that the metaxyphus of *A. kennecottii* (Uhler) is short while that of *A. lucida* Abbott is long and slender.

In addition to the tricks that color patterns may play the student of the Corixidæ, one must be alert to occasional freaks of structure. Some time ago, I received for determination, from Dr. J. G. Needham, a collection of aquatic Hemiptera that he had taken in the west. In this lot I found several males with the asymmetry of the abdomen leftsided, that is, the strigil was sinistral as in the case of the genera Corixa, Trichocorixa and Neocorixa. These insects, however, had the general appearance of the *Arctocorixa edulis* (Champ.) with which they were taken. The male palæ were identical, the strigil the same and the structural detail of the genital capsule also the same, but reversed as shown in Plate VIII, figures 9, 10 and 11. So far as I know, this is the first report of reversed asymmetry in the Corixidæ. It is generally known that in the Corixidæ, the males have the abdominal segments broken up and asymmetrical,* while the females have the abdominal segments regular. In the genus Neocorixa which I described a few years ago, the male abdominal asymmetry is sinistral and the usual strigil is replaced by an area covered with hooklike processes as shown on Plate VIII, Figure 13. The underside of the abdomen of the female is also slightly asymmetrical. Two shiny, shallow depressions on the right side of segment four give the appearance of asymmetry. I have not noticed this in other Corixids. Dr. R. H. Beamer of our department, who conducted an entomological expedition into Texas, New Mexico and Arizona during the past summer, brought me a long series of *Neocorixa snowi* Hungerford which I had described from a few specimens brought back by Dr. Francis Huntington Snow many years ago and for which I erected the new genus. The most abundant catches of the larger Corixids were *Arctocorixa abdominalis* (Say) and *Arctocorixa serrulata* (Uhler). The *N. snowi* Hungerford appears to have about the same geographical distribution. Among the collection of several thousand specimens of Corixids made by Dr. Beamer, Dr. P. A. Readio and Mr. Laurin Anderson on their trip to the southwest are five specimens of a new species taken by Dr. Beamer. This new species may be described as follows:

*See Plate VIII, Fig. 12.

Arctocorixa beameri sp. new.

Size: Short, compact species. Length, 6 mm., width across head, 2.3 mm. Males slightly smaller.

Color: Brown, the pale lineations not conspicuous. About seven pale bands on pronotum, those of hemelytra more or less effaced, the lighter figures very broad, yet so dark that the general effect is dark.

Structural Characteristics: Head broad and short. Interocular space slightly greater than eye width in female. Rear margin of head roundly produced. Pronotum short, rear margin broadly rounded. Surface of pronotum and base of hemelytra somewhat rastrate and entire dorsal surface pebbled except the membrane which is smooth and hyaline. Legs short and stout. Metaxyphus long and slender. Oderiferous gland pores, prominent and guarded by several strong spines. Some of these are matted together to form a very broad, flat plate that tapers from a broad base to a pointed tip. The female pala is of the usual type, that of the male is shown on Plate IX, Figure 9. The strigil is small, round sessile, of five longitudinal rows, the outer and inner one of course very short. The genital capsule of the male as shown on Plate IX, Figure 7.

Described from five specimens (three males and two females) taken by Dr. R. H. Beamer, Cochise County, Arizona, July 29, 1927.

Holotype, Allotype and Paratypes in University of Kansas Entomological collection.

In the family Notonectidæ, there were several hundred Notonecta—mostly *Notonecta kirbyi* Hungerford and *Notonecta lobata* Hungerford—of the larger species in the genus taken in the southwest this summer. I was delighted to find, however, 11 specimens of *Notonecta montezuma* Kirkaldy. These were taken as follows: 10 specimens Vanlentive, Texas, July 13, 1927, R. H. Beamer, 1 specimen Presido Co., Texas July 16, 1927, R. H. Beamer.

This adds considerable information to our knowledge of this species which was described from a male and a female taken in District Federal, Mexico and now located in the Hope Museum, Oxford, England. A drawing of the male genital capsule is shown on Plate IX, Figure 8. The general shape of this capsule is the usual one for the genus. Some species like *Notonecta irrorata* Uhler, *Notonecta borealis* B. & H. in North America and the *Notonecta glauca* group in Europe have a digitate process in place of the keel. Note the very different and unique character of the male capsule and claspers of *Notonecta handlirschi* Kirkaldy (See Plate IX, Fig. 6). Through the very great kindness of Dr. Handlirsch of the Vienna,

Austria, Museum, I have also examined a co-type and believe the unique character of this solitary representative of the genus in Australia should be indicated by a subgenus name. I therefore propose:

Enitharonecta subgenus new

New subgenus in the genus Notonecta—Intermediate between the oriental genus, Enithares, and the widely distributed Notonecta. Anterior lateral margins of protonum embracing the base of the eyes. Last two ventral segments of the male are long and slender, and taken together they remind one of the male operculum of Ranatra. The genital capsule is unique in the genus. The large, flat, plate-like claspers are convex without; concave within, the caudal lobes are greatly reduced.

There are other points in the taxonomy of the Notonectidæ that may be of interest. Dr. Kirkaldy first noted and used the shape of the head in the genus Notonecta. He expressed this character by giving the proportion of the distances between the eyes at their base and at the front as viewed from above, the first to be called the synthlipsis and the second, the vertex. A happier choice of terms might have been proposed. The character itself is of some assistance but varies beyond the limits he expressed. More recently, Dr. Edwards in describing his *Notonecta halophila* separated it from *Notonecta glauca* Linneus by calling attention to the way in which the anterio-lateral points of the pronotum embrace the eyes. While we have since found his species to be *Notonecta viridis* Delcourt, the character is a good one.

Some years ago in searching for some definite way of separating *Notonecta undulata* Say and *Notonecta lunata* Hungerford, I was delighted to discover that the mesotrochanter of the former is rounded as shown in Plate IX, Figure 2, while that of the latter is angulate and often acutely produced, as shown in Plate IX, Figure 4. This has proved useful in separating several other species and should be mentioned in descriptions. Another interesting discovery is the sexual dimorphism of some species of Notonecta. The males of many of them possess small tubercles on the anterior trochanter while the females do not. In *Notonecta shooterii* Uhler and allied species, there is considerable modification of this segment in the males. See Plate IX, Figure 5. Some interesting facts on color in the genus Notonecta are being published in another Journal.

EXPLANATION OF PLATES.

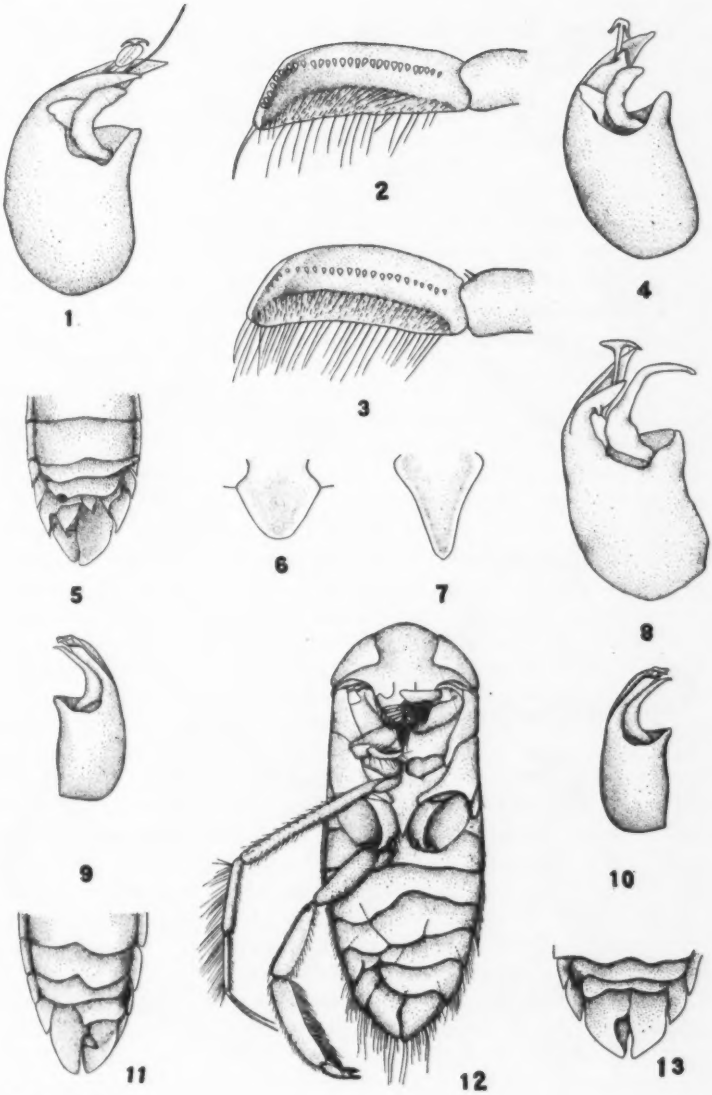
PLATE VIII.

Fig. 1. *Hesperocorixa brimleyi* Kirkaldy—male genital capsule. (Compare with Figure 4).
Fig. 2. *Artocorixa kennecottii* (Uhler)—male pala. (Compare with Figure 3).
Fig. 3. *Hesperocorixa brimleyi* Kirkaldy—male pala. The spines on tibia are not significant. They may have been broken off of Figure 2.
Fig. 4. *Arctocorixa kennecottii* (Uhler)—male genital capsule.
Fig. 5. *Corixa guatemalensis* Champion—dorsal view of male abdomen.
Fig. 6. *Arctocorixa kennecottii* (Uhler) metaxyphus. (Compare with Figure 7, which is the metaxyphus of a species which has been confused with it).
Fig. 7. *Arctocorixa lucida* Abbott. metaxyphus. (Some specimens of this species were labeled co-types of *A. kennecottii* (Uhler). Compare their genital capsules, Figures 1 and 8).
Fig. 8. *Arctocorixa lucida* Abbott—male genital capsule. This species sometimes confused with *Arctocorixa kennecottii* (Uhler).
Fig. 9. *Arctocorixa edulis* (Champion). The male genital capsule of a specimen showing reversed asymmetry. Compare with Figure 10, the usual type.
Fig. 10. *Arctocorixa edulis* (Champion). The male genital capsule-normal individual.
Fig. 11. *Arctocorixa edulis* (Champion). Dorsal view of male abdomen of normal individual. The abdomen of those with reversed asymmetry have the strigil on the other side.
Fig. 12. *Arctocorixa obliqua* Hungerford. Male ventral view, showing the metaxyphus between the hind coxæ and the asymmetrical abdominal segments.
Fig. 13. *Neocorixa snowi* Hungerford. Dorsal view of last abdominal segments showing the nature of the strigil. Compare with Figures 5 and 11 which have the usual type of strigil.

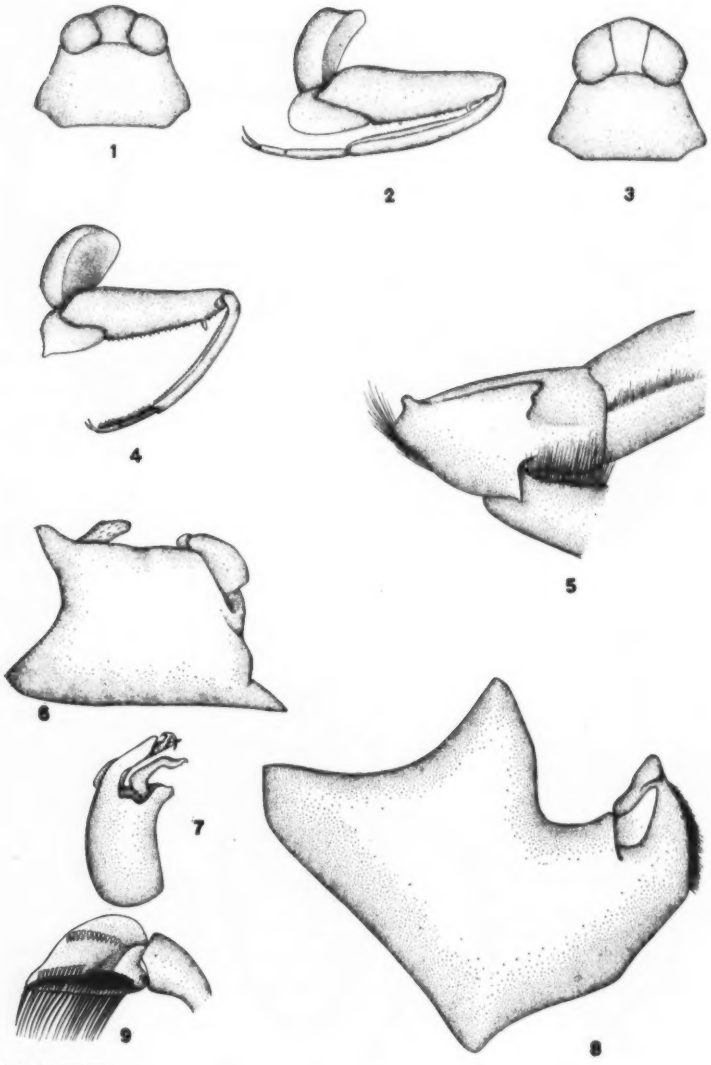
PLATE IX

Fig. 1. *Notonecta viridis* Delcourt—head and prothorax. In this species the head is short, the inner margin of the eyes divergent, giving a wide ratio between synthlipsis and vertex. The anterior margin of the pronotum embraces the eyes. Compare with Figure 3.
Fig. 2. Middle leg of a common Notonecta. Compare the rounded mesotrochanter with the angulate one of Figure 4.
Fig. 3. *Notonecta distincta* Hungerford. (See Figure 1 for comparison).
Fig. 4. Middle leg of a common Notonecta of North America that is often confused with *Notonecta undulata* Say which has the rounded mesotrochanter as shown in Figure 2.
Fig. 5. *Notonecta shooterii* Uhler—showing the curious modifications of the trochanter of the front leg of the male. The female lacks any such structures. Minute prominences are found on the anterior trochanters of the males of a number of our Notonecta. This appears to be the first published record of this sexual dimorphism.
Fig. 6. *Notonecta handlirschi* Kirkaldy. Male genital capsule—so different from the other species of the genus that with other characteristics suggests a separate subgenus. Compare with Figure 8.
Fig. 7. *Arctocorixa beameri* sp. new. Male genital capsule.
Fig. 8. *Notonecta montezuma* Kirkaldy. Male genital capsule of a specimen from Texas.
Fig. 9. *Arctocorixa beameri* sp. new. Male pala.

The drawings on these plates made by Miss Kathleen Doering.



H. B. Hungerford



H. B. Hungerford

GROWTH CONDITION OF THE HOST AS A FACTOR IN INSECT ABUNDANCE

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The presence of insects in unusual numbers is generally recognized as being due to the decrease in environmental resistance, thus permitting the reproductive ability or "Biotic Potential" of the insect to assert itself, at least in part. Environmental resistance as defined by Chapman includes such factors as parasitism and lack of food, also all of the factors usually classified under physical autecology unless these are operating at their optimum.

It is not the intention of the writers to enumerate or discuss the several factors involved, but rather to call attention to one that seems worthy of more notice than has been given in the past, especially when it is considered in relation to insect outbreaks. In discussing food or nutrition as a factor in physical and biotic autecology various texts deal largely with animal groups as they are able to utilize the various simple or complex foods. Vitamins, minerals, symbotic relationships with microorganisms, nitrogen and carbon cycles are also discussed. Considerable space is used to point out that one species of insect may be confined to one host while another species may have hundreds, but little attention is given to the fact that many insects prefer a host when it is in a certain stage of growth. This factor we would call the growth condition of the host. In some instances it is of a physical nature; in others chemical; in others nutritional; or it may be a combination of all. One example falling within this classification is given by Chapman, who cites the fact that the growth of silkworm larvæ may be varied according to the age and condition of the mulberry leaves that are fed to them. This is one of the few cases given in strictly ecological literature. However, when we turn to entomological work, such cases, though usually not treated ecologically, become fairly numerous. The citation of some of the more obvious instances of this nature will show that this factor exists and is of considerable importance.

One of the best known examples is that of the shot hole borer, *Eccoptogaster rugulosus* Ratz. This insect rarely breeds in healthy trees but if the tree becomes weakened it is able to multiply in it in countless numbers. The host is still alive and usually is making some growth but its condition has been so changed that an outbreak of this particular insect is inevitable, whereas previously this was impossible.

The development of plum curculio larvæ in apple may be cited as an example of the physical phase of growth condition as affecting the insect. Eggs that are laid in apples that drop from the tree hatch and the larvæ develop normally. Of the eggs laid in fruit that remains on the tree, some may hatch but the larvæ never attain maturity. It has been suggested that this is because the rapidly proliferating cells of the apple crush the eggs and young larvæ. The fact that the apple is growing, effectually prevents the development of the insect, as it has been shown that the curculio can be reared in mature fruits in which growth has ceased.

In Georgia the Oriental fruit moth has proven to be a pest of a very minor order. Snapp explains this by pointing out that the crop of peach fruits in Georgia is harvested usually in July, thus depriving the larvæ of the food usually selected during the late summer and fall season. However, due to the long warm season breeding continues and the larvæ are forced to feed on twigs which have passed their season of active growth and have become well hardened. Though in spring and early summer the growing terminals are favorite food, the mortality of larvæ feeding on hardened twigs is so great that the Oriental fruit moth in its later broods is starved almost to the point of extinction. Thus the growth condition of the host has effectually prevented outbreaks of this insect in Georgia. In the northern United States, where peaches are harvested in late August and September, the larvæ have favorable food almost to the end of the breeding season and so are able to enter hibernation in large numbers. It is for this reason that late peaches invariably suffer more severely than the earlier varieties. Stearns (unpublished data) has shown, however, that in case the peach crop is a failure, the same condition will arise as exists in Georgia, namely, that the larvæ will starve by being forced to feed on hardened twigs.

The corn leaf aphis, *Aphis maidis* Fitch, in its relationship to the corn plant affords an excellent illustration of host preference at a certain stage of growth. Gui has found that as corn nears the tasseling stage it becomes heavily infested with this species and reproduction is at the maximum till the tassel fully emerges. While the corn plants in the field are still small, sorghum is the preferred host. These observations were further confirmed by rearings conducted in the greenhouse. In these experiments a given number of aphids was placed on each of several hosts. Of the aphids that were placed on sorghum and barley, about 50% matured and reproduced; on wheat, 20%; on oats, 4%; while on corn, the percentage was only 3. As young plants only were used, this demonstrates conclusively that the aphid prefers corn in a certain stage of growth. Gui further states that on the sorghums and barleys the individual aphids lived longer and produced more young.

In 1920-21 it was generally observed by growers and entomologists in southern Indiana and Illinois and in Missouri and Arkansas that San Jose scale was seriously increasing in numbers. Up to this time lime sulfur was the standard dormant spray and had held the insect well in check. The failure of lime sulfur to control has not been explained but suddenly in spite of careful spraying the scale increased tremendously. The phase of the situation that concerns this paper is this: The neglected orchards that were poorly sprayed or not sprayed at all and those that were both pruned and fertilized indifferently were not particularly attacked. Orchards that had received every care in pruning, spraying and fertilization and that were making vigorous growth were the ones that suffered and in which the great scale populations were to be found. Every evidence points to the fact that trees in a healthly and vigorous condition of growth favored the scale and that this was one of the causal factors of the outbreak.

DeLong in his recent work with the bean leaf hopper, *Empoasca fabæ*, has produced striking results showing that this insect does not select potato plants as food and for oviposition till they have attained a considerable growth. Till this time, bean is the favorite host. Eggs are deposited upon the bean plants as soon as they are through the ground but the leafhopper neither feeds nor oviposits upon the potato

until almost a month later although the potato plant is frequently through the ground before the bean plant.

The above examples illustrate the factor to which we would call attention. Furthermore the writers working independently have each found an example of this factor which shows it to be of great importance. Since 1922 the senior author has conducted each year at Wooster, Ohio, some research with the green apple aphis, *Aphis pomi* DeGr. In addition to various experimental control measures, considerable time has been taken to observe outbreaks of this insect. The beginnings, growth, peak and decline of the colonies during the periods of abundance were noted and attempts made to locate the causal factors. The over-wintering eggs of the green apple aphis hatch during the last two weeks of April. According to the season and the growth condition of the twig on which the stem mother is located, a varying percentage of her progeny develop wings. Vigorous terminals and watersprouts are found by the migrants and colonies are soon formed. Conditions are now in readiness for a possible outbreak, and whether or not this occurs depends on one thing—the growth condition of the host. At this season of the year (late May and early June) the terminal buds of apple have broken and twig growth is starting. The vigor of such growth and the length of the period over which it takes place will determine the degree of aphis infestation. In 1925, the month of May was below normal in temperature with considerable rainfall. Twig growth was progressing slowly when during the first week in June a period of high temperature started which lasted for three weeks. With sufficient moisture in the soil the trees were thrown into vigorous growth, thus furnishing the aphids with an abundant and favorable food supply. A severe outbreak occurred in late June and early July which was soon checked by early hardening of the terminals due to the fact that there was little rainfall accompanying the warm weather. In 1926, during May, June and July twig growth was at no time sufficiently vigorous to support an outbreak. However, due to many rains in August young apple trees made a vigorous growth and became heavily infested in late August. In 1927, different conditions were again noted. The summer was cool with no protracted heat periods to evaporate moisture from the soil. Twig growth was late in getting started but once begun it

continued throughout the summer. These conditions permitted a serious outbreak which lasted over a longer period of time than is usual. Any condition that tends to produce succulent growths, such as rich soil, cultivation, fertilization, or certain types of pruning, is favorable to the aphids. In 1925 in the Bingham orchards at Chardon, Ohio, a check plot of twelve trees that were unfertilized and uncultivated was observed. These were surrounded by the main orchard, all of which was either fertilized or cultivated and which was heavily infested by aphids. On the check plot there was no infestation, only rarely could an aphid be found, the trees were growing and healthy but the condition was not right to support an outbreak. If they have attained some age, unfertilized and uncultivated trees never have a serious infestation. In any season it is the succulent twigs that carry the aphid population. Vigorous terminals and watersprouts that normally first start growth in the spring and are last to "harden" in the autumn are always to be found infested if any aphids are present. It has been shown that outbreaks of some aphids have been terminated by parasites, predators, or diseases. Outbreaks of the green apple aphis, however, are not terminated in this manner but cease because of the hardening of the twigs, thus causing the death or the migration of the occupants.

The work of the junior author and his associate, C. R. Neiswander with the European corn borer has shown that the growth condition of corn affects the ultimate borer population in two ways; First, in regard to varieties of corn planted on the same date and on the same soil, and second, in regard to varieties that are planted on different dates. The various biologic phases of the corn borer life history as directly affected by the weather, etc., do not change greatly from season to season. The moth flight, for example, is usually at its height about July 10. Therefore, various corn varieties planted on the same date will be equally infested unless there are certain different growth conditions in the varieties that change this premise. Such has been shown to be the case. During the period of larval establishment the varieties have reached varying stages of growth, some of which are more favorable to the larvæ than others. Some varieties, therefore, although planted on the same date carry a heavier borer population, because the growth condition permits more larvæ to successfully establish themselves.

Growth condition of the same varieties of corn as influenced by planting on different dates also directly affects the borer population. Early planted corn always carries a heavier borer load than corn planted late. The reason for this is twofold; In the first place the early planted corn has reached a stage of growth during moth flight when it is highly attractive to the corn borer moths. During moth flight observations have shown that the greatest number of individuals are always present over the early planted fields and what is still more significant from the standpoint of ultimate infestation, the greatest number of eggs are to be found in these early fields. Furthermore, laboratory studies have shown that the moths are more strongly attracted to distillates from early corn than to those from late corn.

In the second place the same growth condition operative in influencing rate of establishment of larvæ on different varieties of corn planted on the same date also apparently determines to a great extent the rate of establishment on the same variety planted on different dates. From the data at hand it may be concluded that early planted corn is more severely attacked, not necessarily because there is no other corn to be infested but because of its condition of growth or stage of development. As has been pointed out above the same conditions which affect growth condition of apple trees and indirectly the behavior of the apple aphis likewise affect the growth condition of corn and the consequent behavior of the corn borer.

While preparing this paper the writers were impressed with the fact that five men of the Department of Entomology of the Ohio Agricultural Experiment Station, each working independently, had noted this factor in one or more problems with which he has been engaged. It is a fact common to all entomologists that before applying control measures of any type that the plots to be treated must be composed of plants of the same variety and in the same condition of growth; otherwise the results cannot be considered comparable. The physical factors, such as temperature, moisture, light, etc., are of undoubted and proven importance as they directly affect the life of animals. However, the indirect effect as it may be measured through the growth condition of the host is of great importance. There are undoubtedly cases in which it explains the varying degree of infestation both locally and in widely

separated areas. It would, therefore, seem that more effort should be made to locate this factor in biological studies, and after its importance is ascertained that attempts should be made to utilize it in applied work.

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BOOK REVIEWS.

HISTOLOGICAL TECHNIQUE, by B. F. KINGSBURY AND O. A. JOHANNSEN; 142 pages, 16 figures. Published by John Wiley and Sons.

This is the most conveniently arranged guide to histological technique that has been published. It is down to date and is limited to the standard methods of known worth. Professor Kingsbury has long been an authority on all branches of histological technique while Professor Johannsen has studied those methods of most value in preparing insect tissues. The book contains such methods as that of double embedding which is so necessary in much work on insects because of the intimate association of very hard and very watery tissues, a method hardly mentioned in other similar works devoted largely to vertebrate histology. The volume is convenient in size and well bound for hard laboratory usage.

—C. H. KENNEDY.

INJURIOUS INSECTS, by GLENN W. HERRICK; 489 pages, 458 figures. Published by Henry Holt and Co.

The first eighty-four pages of this excellent synopsis of American economic Entomology are given to eleven compact chapters on the losses due to insects and to the general principals of control. The body of the book deals in more detail with nearly three hundred pests. The uniformly high quality of the many illustrations is the most striking feature. With each is given the magnification, a second item of value. With this high quality of the illustrations, the deadly technical descriptions are reduced usually to mere color characters. The thumb-nail maps of distribution add an ecological interest and give an immediate visual check on locality. Great care has been given to give the latest methods of control and to omit all but those proven to be of greatest value. The whole volume reflects long and arduous work and has the polish and clear-cut accuracy one expects in Professor Herrick's publications.—C. H. KENNEDY.

PROCEEDINGS OF THE TWENTY-SECOND ANNUAL MEETING.

Nashville, Tennessee, December 27 and 28, 1927.

The twenty-second annual meeting of the Entomological Society of America was held at Nashville, Tennessee, December 27 and 28, 1927. An unusually interesting program with important contributions characterized the meeting. The attendance at the sessions ranged from 60 to 100, with about a total of 140 members present at one or more sessions.

The annual public address was delivered by Dr. H. T. Fernald and was thoroughly appreciated by everyone present. His lecture, "Insects, the People and the State," dealt in a masterful way with the history of applied entomology and its wonderful development. The symposium, "The Physiology of Insects," was handled exceptionally well by Doctors Kennedy, Welch, Minnich, Robinson and Parker, and was enjoyed by all present.

Opening Session, Tuesday Morning, December 27.

The Society was called to order at 10:05 A. M. by President F. E. Lutz, in the South Gymnasium of the Southern College of the Y. M. C. A., Nashville, Tennessee. Attendance, 100. The following papers were presented, those starred, by title only:

1. Preliminary Notes on the Feeding Habits of the Chinch Bug, with Reference to Injury to Plant Cells. REGINALD H. PAINTER, Kansas State Agricultural College.
2. Life Histories of *Corizus hyalinus* (Fab.) and *C. sidæ* (Fab.) (Coreidæ, Hemiptera). PHILIP A. READIO, University of Kansas.
3. Observations on the Habits of a Phorid (Diptera). W. V. BALDUF, University of Illinois.

*4. The Catalase Activity During Metamorphosis of Insects. DAVID E. FINK, University of Pennsylvania.

*5. Humidity Extremes Borne by the Japanese Beetle, *Popillia japonica* Newm. NELLIE M. PAYNE, University of Pennsylvania.

*6. The Respiratory Significance of the Periodic Vibratory Movements in the Larva of *Nymphula maculalis*. (Lepidoptera). PAUL S. WELCH and GEORGE LOUISE SEHON, University of Michigan.

*7. Digestive Enzymes of the Oriental Fruit Moth. H. S. SWINGLE, U. S. Bureau of Entomology.

*8. Alternating Light and Darkness as a Producer of Wings of Aphides. A. FRANKLIN SHULL, University of Michigan.

9. The Biological Control Factors of the Immature Stages of *Euxoa ochrogaster* Gn. in Saskatchewan (Lepidoptera). KENNETH M. KING and N. J. ATKINSON, Canada Entomological Branch.

10. Use of the Thermal Constant in Timing Spray Treatments. T. J. HEADLEE, New Jersey Agricultural Experiment Station.

F. Martin Brown gave an interesting extemporaneous talk on "Enzymes in the Alimentary Tract of the Honeybee."

G. W. Herrick discussed the International Entomological Congress to be held at Ithaca and Geneva, N. Y., August 11-18, 1928. See p. 165.

The following committees were appointed by President Lutz:

Nominating Committee—E. P. FELT, Chairman; W. A. RILEY, G. A. DEAN.
Resolutions Committee—P. B. LAWSON, Chairman; A. C. KINSEY, W. J. SCHOENE.
Auditing Committee—H. B. HUNGERFORD, Chairman; W. P. FLINT, H. E. HODGKISS.

On motion the Secretary was instructed to send telegraphic greetings to John Henry Comstock. The following night letter was sent by the secretary:

John Henry Comstock, Ithaca, New York.

The Entomological Society of America extends greetings to you and Mrs. Comstock. All your old friends send best wishes and appreciation.

J. J. DAVIS, *Secretary.*

Second Session, Tuesday Afternoon, December 27.

The Society was called to order at 1:30 P. M. in the South Gymnasium of the Southern College of the Y. M. C. A., by President Lutz. Attendance, 85. The following symposium was presented:

"THE PHYSIOLOGY OF INSECTS."

Introductory Remarks.....C. H. KENNEDY
I. Metabolism.....P. S. WELCH
II. Special Sensory Responses of Insects.....D. E. MINNICH
III. Responses and Adjustments to External Stimuli.....WM. ROBINSON
IV. Reproduction.....R. L. PARKER
Concluding Remarks.....C. H. KENNEDY

Third Session, Tuesday Evening, December 27.

The Society was called to order at 8:20 P. M. in the Auditorium of Neeley Chapel, Vanderbilt University, by President Lutz. Attendance about 60.

The Annual Public Address given at this session was made by Dr. H. T. Fernald on the Subject "Insects, the People and the State."

Fourth Session, Wednesday Morning, December 28.

The Society was called to order at 10:10 A. M. in the South Gymnasium of the Southern College of the Y. M. C. A., by Vice-President Hinds. Attendance, 85. The following papers were presented:

11. The Legs and Leg-bearing Segments of Pauropoda, Symphyla and Apterygota, with Notes on Leg-segmentation in the Arachnids. H. E. EWING, U. S. National Museum.
12. Insect Hosts of Plathyhelminth Parasites. E. W. STAFFORD, Mississippi Agricultural College.
*13. The Epipharynx of Lamellicorn Larvæ. (Coleoptera). WM. P. HAYES, University of Illinois.
*14. A Demonstration of the Location of the Auditory Organs in Certain Orthoptera. B. B. FULTON, Iowa State College.
15. The Genus Driotura. (Cicadellidæ, Homoptera). PAUL B. LAWSON, University of Kansas.
16. Studies on Kansas Cicadas. RAYMOND H. BEAMER, University of Kansas.
17. Some Recent Studies in Aquatic Hemiptera. H. B. HUNGERFORD, University of Kansas.

18. Reliability of the Egg Mass Character as a Factor in Classification of Chironomidæ. HAZEL E. BRANCH, University of Wichita.
19. Key to the Genera of Tachinidæ. (Diptera). C. H. CURRAN, Canadian Department of Agriculture.
20. Some Poisonous Arthropods of Durango, Mexico. W. J. BAERG, University of Arkansas.
21. The Biotic Factor in the Environmental Resistance of *Anthophora occidentalis* Cress. (Apidæ, Hymenoptera). C. E. MICKEL, University of Minnesota.

Fifth Session, Wednesday Afternoon, December 28.

The Society was called to order at 1:40 P. M. by President Lutz, in the South Gymnasium of the Southern College of the Y. M. C. A. Attendance, 60. The following program was presented:

22. The World Distribution of the Genus Macromia, Strong-flying River Dragonflies that Apparently Originated in America. CLARENCE H. KENNEDY, Ohio State University.
23. The Intestine of the Boll Weevil, with Notes on the Effect of Calcium Arsenate on the Cells of the Hind Intestine. R. W. LEIBY, North Carolina State Department of Agriculture.
24. Collecting on the Roof of a High Building. E. P. FELT, New York State Museum.
25. A Summary of the Courses in Entomology Offered by Institutions of Higher Learning in the United States. ROGER C. SMITH, Kansas State Agricultural College.

The Annual Business Meeting followed the reading of the papers, as follows:

REPORT OF THE SECRETARY.

Previous to July 1, 1927, the following having been duly nominated and recommended, were elected members of the Society by mail ballot of the Executive Committee:

LAURENCE VAIL COLEMEN, Amer. Assn. Museums, Washington, D. C.
GEORGE AUGUSTUS FICHT, Purdue Univ. Agr. Exp. Sta., Lafayette, Ind.
GEORGE L. HOCHENYOS, Springfield, Ill.
FRED C. HADDEN, H. S. P. A. Expt. Sta., Honolulu, Hawaii.
JUDSON DUNBAR IVES, Carson & Newman College, Jefferson City, Tenn.
JONATHAN ALEXANDER MUNRO, State Agr. Exp. Sta., Fargo, N. Dak.
HERBERT JOHN PACK, Utah Agr. Exp. Sta., Logan, Utah.
ERNEST SCHWARZ, Game and Fish Dept., Jefferson City, Mo.
FLOYD F. SMITH, Greenhouse Insect Laboratory, Willow Grove, Pa.
LOREN F. STEINER, Purdue Univ., Agr. Exp. Sta., Lafayette, Ind.
HAROLD FRANCIS WILLARD, U. S. D. A., Honolulu, Hawaii.

By direction of the Executive Committee, Dr. H. T. Fernald was invited to give the annual public address of the Society at the Nashville meeting. It was also decided to hold a symposium on the subject, "The Physiology of Insects."

Prof. G. N. Bentley kindly consented to act as local representative for the Nashville meeting.

On April 2, 1927, by direction of the Executive Committee, Dr. C. W. Stiles was nominated for re-election as a member of the International Commission on Zoological Nomenclature. On the same date, we suggested to Dr. Agnes L. Rogers, Bryn Mawr College, the names of Dr. Edith M. Patch, Dr. Annette F. Braun, and Dr. Anne H. Morgan to represent the Society on the Committee on Fellowships of the International Federation of University Women. Dr. Edna Mosher was suggested as an alternate.

On July 3, 1927, President Lutz appointed Dr. L. O. Howard as our delegate to the 1927 International Zoological Congress at Budapest.

The Executive Committee met at 4:00 P. M., December 27, in the South Gymnasium of the Southern College of the Y. M. C. A., Nashville, Tenn., the following members present: F. E. Lutz, Herbert Osborn, W. E. Hinds, and J. J. Davis. Special members present to fill vacancies included C. H. Kennedy, E. P. Felt, and W. J. Baerg. The committee received brief informal reports of Herbert Osborn as Managing Editor of the Annals, and of J. J. Davis, as Secretary and Treasurer of the Society and as Treasurer of the Thomas Say Foundation.

The following members were elected:

CHARLES FREDERICK ADAMS, Ind. St. Bd. Health, Indianapolis, Ind.
WHITEFORD LEE BAKER, Univ. Minn., Minneapolis, Minn.
G. A. BIEGERDORF, A. and M. College, Stillwater, Okla.
WESLEY G. BRUCE, Kansas St. Agr. College, Manhattan, Kans.
MARVIN H. BRUNSON, Iowa St. College, Ames, Iowa.
EDWARD DONALD BUCKELL, Ent. Laboratory, Vernon, B. C.
ROBERT W. BURRELL, Jap. Beetle Laboratory, Moorestown, N. J.
CHARLES F. CLAGG, Mass. Agr. College, Amherst, Mass.
FRANK WALDO CRAIG, St. Dept. Agr., Charleston W. Va.
ALONZO CLAYTON DAVIS, Garden Grove, Calif.
FERDINAND F. DICKE, U. S. Corn Borer Laboratory, Monroe, Mich.
J. ALFRED ELSON, Gustavus Adolphus College, St. Peter, Minn.
C. K. FISHER, Alhambra, Calif.
CHARLES LOUIS FOX, San Francisco, Calif.
FORREST GARNER, Kans. Agr. College, Manhattan, Kans.
JOHN GRAY, Univ. Florida, Gainesville, Fla.
PERRY KIPS HARRISON, Picayune, Miss.
JOHN H. HAWKINS, Agr. Exp. Sta., Orono, Me.
ERIC HEARLE, Indian Head, Saskatchewan.
E. HAROLD HINMAN, Cornell Univ., Ithaca, N. Y.
F. G. HOLDAWAY, Univ. Farm, St. Paul, Minn.
RALPH HOPPING, Vernon, B. C.
HORACE FREDERICK HUDSON, Ent. Laboratory, Strathroy, Ontario.
ELMER T. JONES, U. S. D. A., Wichita, Kans.
GEORGE EDWARD KING, Okla. A. and M. College, Stillwater, Okla.
FRANK BRADSHAW MAUGHAN, Wellsville, Utah.
ELLIOTT A. MAYNARD, Rochester, N. Y.
ROY MELVIN, Iowa St. College, Ames, Iowa.
WILLIAM PITT MORGAN, Indiana Central College, Indianapolis, Ind.
PAUL N. MUSGRAVE, Fairmount, W. Va.
A. A. NICHOL, Univ. Ariz., Tucson, Ariz.
J. H. O'DELL, Ariz. Comm. Agric. and Hort., Phoenix, Ariz.
MIRIAM A. PALMER, Colo. Agr. College, Ft. Collins, Colo.
ORLANDO PARK, Chicago, Ill.
HARLAND KEIPER RILEY, Purdue Univ. Agr. Exp. Sta., Lafayette, Ind.
SIEVERT ALLEN ROHWER, Bur. Ent., Washington, D. C.
FRANK E. SHAEFFER, State Entomologist's Office, Indianapolis, Ind.
CHESTER WEBB SMITH, Chatham, Ontario.
ALAN STONE, Cornell Univ., Ithaca, N. Y.
K. C. SULLIVAN, Univ. Missouri, Columbia, Mo.
THOMAS MALCOLM STREET, N. Dak. Sch. Forestry, Bottineau, N. Dak.
VASCO M. TANNER, Brigham Young Univ., Provo, Utah.
RALPH VORIS, Indiana University, Bloomington, Ind.
C. B. WISECUP, Manhattan, Kans.
GEORGE ZEBROWSKI, Villa Nova College, Villa Nova, Pa.

MR. KENNETH DAVIS DOAK, Purdue University Agricultural Experiment Station, Lafayette, Indiana, was elected to Life Membership.

The following members have died during the year:

KENNETH F. AUDEN
CHARLES FULLER BAKER
M. BEZZI
ANDREW FLEMING
WM. LOCHHEAD
FREDERICK L. WASHBURN

The following persons resigned during the year and their membership terminated December 27, 1927: G. G. Ainslie, G. T. Bethune-Baker, E. H. Blackmore, R. Bogue, B. S. Bronson, A. C. Burrill, Mrs. Sara Hoke DeBord, J. F. Dirschmidt, C. T. Dodds, S. B. Doten, V. Duran, E. M. Ehrhorn R. G. Harris, H. E. Jaques, S. C. Kleene, C. P. Lounsbury, Adolpho Lutz, M. Y. Marshall, S. L. Mason, Carlos Moreira, Wirt Robinson, W. P. Rogers, W. A. Scott, R. B. Smith, T. J. Talbert.

The following have been dropped because of arrears in dues: W. G. Howes and F. M. Littler.

Total membership December 28, 1926		783
Members lost by death	6	
Members lost by resignation	25	
Members lost by delinquency	2	
Total loss in membership		33
Balance		750
New members elected during 1927		57
Total present membership		807

Herbert Osborn was nominated by the Executive Committee for Honorary Fellow. (Election verified by mail ballot to Fellows—J. J. D.)

The following members were elected to fellowship by the Executive Committee: A. N. Caudell, R. N. Chapman, R. W. Harned, H. B. Hungerford, C. H. Kennedy, Phil Rau, and R. E. Snodgrass.

The following were elected members of the Thomas Say Foundation to succeed themselves: J. Chester Bradley and Arthur Gibson.

The following were elected members of the Editorial Board of the Annals: L. Caesar, C. T. Brues and P. S. Welch, to succeed Arthur Gibson, Edith M. Patch and W. A. Riley.

The Executive Committee recommended that the Society contribute $150.00 towards the promotion of the International Entomological Congress, to be held at Ithaca, New York, next August.

Respectfully submitted,

J. J. DAVIS, *Secretary.*

Report accepted and on specific motion, the recommendations for memberships and for appropriating $150 00 toward the expenses of the 1928 International Entomological Congress were approved.

REPORT OF THE TREASURER.

CURRENT FUNDS.

RECEIPTS.

Balance, December 28, 1926, (See Annals, XX, p. 135)	$3,048.13
From Annual Dues of Members	2,106.62
From Managing Editor of the Annals	981.23
Interest on Bonds	47.33
Interest on Savings Account, July 1, 1926, to June 30, 1927	65.44
Total	$6,248.75

EXPENDITURES.

Printing 1926 Programs	$ 32.00
Printing March, June and September Annals	1,640.10
Ledgers and Journal	2.60
Expenses of Code Committee	35.88
Account Forms	23.17

Printing Letter Heads	5.75
Printing 1927 Preliminary Notices	8.50
Rubber Stamp	.33
Stamped Envelopes and Stamps	72.11
Clerical Service	87.50
Refund to C. H. Kennedy for Cut	7.72
Total	$1,915.66
Balance, Cash on Hand, Purdue State Bank, December 21	4,333.09
	$6,248.75

LIABILITIES.

The Society owes the publishers of the Annals for the December, 1926, March, June and September, 1927, issues, totaling $2,472.03. We also owe about $30.00 for printing programs and a small amount for clerical service. At least $100.00 in checks have been received since the books were closed.

PERMANENT FUND.

The Society held United States and Canadian Liberty Bonds totalling $1,100.00, as listed in the Annals, Vol. XIX, p. 108. The $400.00 of Second United States Liberty Bonds were cashed November, 1927, and temporarily placed in bank account. Also, a life membership of $50.00 was added to the permanent fund, making a total of $1,150.00.

Respectfully submitted,

J. J. DAVIS, *Treasurer.*

On motion the Treasurer's Report was accepted, subject to the approval of the Auditing Committee.

REPORT OF THE MANAGING EDITOR OF THE ANNALS.

In making a report for the year it may be in place to call attention to the fact that this completes the twentieth year for the Annals, and I think it may safely be said that it represents as successful a year as any in the past and shows a very satisfactory growth from its beginning. In spite of adverse conditions during the War period, not a single number has failed to appear, and, except for some reduction in size during the War period, the amount of material presented has had a fairly continuous growth. The current volume of 558 pages means that members are receiving the Annals for a trifle over a half cent per page.

Aside from nearly 800 members who receive the Journal, we have about 150 non-member subscribers, mostly libraries, and a considerable number of these are in foreign countries. The Journal is sent to each state in the Union except Vermont, and to Hawaii, the Philippines, Porto Rico and the Canal Zone. The Canadian provinces receive 46. Of the other foreign subscriptions, Japan leads with 19, India receives 7, Russia 6, Brazil, England, France and Germany 5 each, Cuba 4, Australia, China, Chile, Egypt, and South Africa 3 each, Java, New Zealand, Peru, and Nova Scotia 2, and 1 each to Argentine, Austria, Belgium, Bermuda, Ceylon, Denmark, Hungary, Italy, Malay Peninsula, Mexico, Roumania, Sweden, Switzerland, and the West Indies.

As in previous years we have been favored with contributions from various authors and institutions, and I may mention particularly one from the Rockefeller Institute for Medical Research.

Income and expenditures may be summarized as follows:

RECEIPTS.

Subscriptions, Non-member	$ 501.75
Contributions, Illustrations, etc	428.37
Reprints Sold	237.66
Back Volumes and Numbers	159.05
Total	$1,326.83

DISBURSEMENTS.

Paid for Engravings	$ 273.60
Postage, Stamps and Mailing Charges	46.08
Subscriptions Returned to Treasurer	17.60
Clerical Help	4.00
Incidentals	4.32
Balance turned over to Treasurer	981.23
Total	$1,326.83

In conclusion I wish to express my continued obligation to Dr. C. H. Kennedy, who has borne the burden of attending to the collections, keeping of accounts and the laborious duty of handling the mailing list. I am also indebted to members of the Editorial Board for aid in the securing of available papers and I think it only fair to mention that we have had the heartiest co-operation from the printers, Spahr and Glenn, who have had the printing of the Annals throughout the entire twenty years.

Respectfully submitted.

HERBERT OSBORN, *Managing Editor.*

On motion the Report of the Managing Editor of the Annals was accepted, subject to the approval of the Auditing Committee.

No report was received from Editor J. M. Aldrich of the Thomas Say Foundation.

REPORT OF THE TREASURER OF THE THOMAS SAY FOUNDATION.

For the Year 1927.

RECEIPTS.

Balance on hand January 1, 1927, (See Annals XX, p. 137)	$ 48.88
Sale of Vol. I—6 @ $3.00	18.00
Due on volumes delivered, $6.00.	
Sale of Vol. II— 5 @ $4.50	22.50
1 @ 4.95	4.95
16 @ 5.00	80.00
Due on volumes delivered, $14.95.	
	$174.33

EXPENDITURES.

Postage on Volumes Mailed	$ 5.22
Postage	2.50
Interest on loan of $500.00 at 6%, July 1, 1926, to December 30, 1927, one and one-half years	45.00
Cash to reduce loan	100.00
Balance on hand	21.61
	$174.33

There is a balance due on loan to pay for printing volume II of $400.00.

Respectfully submitted,

J. J. DAVIS, *Treasurer.*

On motion the report was accepted, subject to the approval of the Auditing Committee.

The Auditing Committee, consisting of H. B. Hungerford, Chairman, W. P. Flint, and H. E. Hodgkiss, reported that the books of the Managing Editor of the Annals, of the Treasurer of the Society and the Treasurer of the Thomas Say Foundation had been examined and found apparently correct.

REPORT OF COMMITTEE ON RESOLUTIONS.

1. That we express our hearty appreciation of the efforts of the Nashville committee and of its splendid arrangements for our meetings and entertainment. Especially do we commend the committee for the excellent rooms secured, both for our meetings and for the exhibitions.

2. That we express our appreciation to the Bausch & Lomb Company, for their courtesy in the loan and operation of the balopticon.

3. That the Society learns with deep regret and a sense of distinct loss of the death, during the year, of the following members:

KENNETH F. AUDEN
C. F. BAKER
M. BEZZI
ANDREW FLEMING
WILLIAM LOCHHEAD
F. L. WASHBURN

4. That the Society notes with keen interest the Report of the Committee on Policy, adopted at the 1926 meeting of the Association of Economic Entomologists, looking toward the broader training of entomologists in the fundamental sciences and toward the meeting of the need of purely fundamental investigations in the several fields having to do with our science. And further, the Society expresses its earnest desire to co-operate with the Association in every possible way in the furtherance of this movement.

5. That the Society expresses its deep appreciation of the faithful and most capable work of Doctors Herbert Osborn and Clarence H. Kennedy in making the Annals of the Entomological Society of America such a highly prized medium of publication, and that the Society declare itself as strongly favoring such increase in the size of the Annals as shall enable it to meet more adequately the constant and increasing demands made on it for publication.

Respectfully submitted,

PAUL B. LAWSON, *Chairman*,
W. J. SCHOENE,
A. C. KINSEY.

By vote of the Society the report was accepted.

REPORT OF THE NOMINATING COMMITTEE.

The Nominating Committee beg to report the following names as nominees for the respective offices for the year 1928:

President—E. O. ESSIG.
First Vice-President—EDITH M. PATCH.
Second Vice-President—W. D. FUNKHOUSER.
Secretary-Treasurer—J. J. DAVIS.
Additional Members of the Executive Committee—For term expiring December 31, 1930—C. H. KENNEDY and E. C. VAN DYKE.
Councillors to the American Association for the Advancement of Science—J. M. ALDRICH and C. L. METCALF.

The Committee on National Museum was continued with the same personnel.

Respectfully submitted,

E. P. FELT, *Chairman*,
GEO. A. DEAN,
W. A. RILEY.

By vote of the Society the report was accepted and the Secretary instructed to cast a unanimous ballot for the election of the persons nominated. This being done, they were declared elected.

The National Museum Committee then reported as follows:

REPORT OF COMMITTEE ON NATIONAL MUSEUM.

In accordance with the request at the Kansas City meeting, your committee sent requests to the various institutions where collections were known to be maintained, including a number of public museums, not strictly "state," but where important collections are available for consultation by qualified students. This list included about forty and replies have been received from most of them. A number, however, simply report no additions of special note since the report of a year ago and others state simply routine progress or the usual accretions from department work.

The National Museum collections have received a number of notable accessions. Dr. W. Schaus donated a valuable collection of 10,000 specimens of moths, chiefly from Bolivia, which were purchased by him from a collector in that country.

The collection of insects which had been formed by the Division of Truck Crop Insect Investigations was transferred to the Museum. This collection gives a good series of many important economic pests, and associates immature stages with adults. The specimens are connected with notes by Bureau numbers under the Chittenden series.

The Henry F. Schoenborn collection of butterflies and moths was donated by his children to the National Museum. It is in good condition, and especially rich in local material from the neighborhood of the District of Columbia. It also contains many European species and other material of value.

Dr. George Dimmock gave the National Museum his collection of adults larvæ, slides and notes, consisting of fifteen large double boxes of pinned material; about 3,500 small glass tubes of material preserved dry, consisting of the shed skins of larvæ of all stages, pupæ, some adults, and all of the parasites which emerged in the course of Dr. Dimmock's rearings; a small amount of alcoholic material; about 2,650 numbered notes, which in many cases are extremely detailed, covering three or four pages. This collection was brought to Washington from Springfield, Mass., by Dr. E. A. Chapin, and is being distributed and incorporated under his direction.

The C. F. Baker collection of insects, which is reported to include more than 1,450 Schmitt boxes of pinned specimens, a large quantity of unmounted material, and a very extended card index of reference to Indo-Malayan entomology, has been bequeathed to the U. S. National Museum. It contains many types and hundreds of species new to the National Collection. This collection will be packed and shipped to this country under the direction of Mr. R. A. Cushman, who was sent to the Philippines for this purpose, the expenses of his trip being borne jointly by the Museum and the Bureau of Entomology.

Mr. George M. Greene, of Harrisburg, Pa., donated his valuable collection of insects to the National Museum. His collection contains about 48,000 specimens, 42,000 being Coleoptera, all well mounted, labeled and determined.

Additions to the Canadian National Collection have been made by field survey work in the regions of Point Pelee, Ontario; Covey Hill, Knowlton and Kazubazua, Quebec. The number of species of which type material is now contained in this collection has been increased to 2,775.

For the Museum of Comparative Zoology, the family of the late Mr. Fred. C. Bowditch has presented his great collection of Coleoptera to the Museum of Comparative Zoology. There are two principal portions, (1) a general collection of Coleoptera of the world based on the famous G. D. Smith collection, and (2) special collection of the Chrysomelidæ, containing the Jacoby collections (except part of the second), the Tring Museum collection, and an enormous amount of other material. Of the Chrysomelidæ there is an arranged collection in over 250 double boxes contained in 20 metal cabinets, and an immense amount of miscellaneous material, partly unassorted. The Jacoby collection contained over 2,000 types, and Mr. Bowditch added several hundred more. About 3,000 specimens of Hymenoptera, Homoptera and Neuroptera were purchased from J. Steinback, of Bolivia. The other additions were of small lots, several, however, containing types. The Arthur Leveridge collection of East African insects, purchased for the museum, about 20,000 specimens, half Coleoptera, the butterflies and a few

other groups named. Also the Carnochan collection of Histeridæ was presented to the Museum, 28 Schmitt boxes.

At Clemson College: After a disastrous fire our insect collections were started anew in the autumn of 1925. The collection now occupies about 150 boxes, mostly of the Schmitt type. The intent is to develop an accurately identified reference collection of all species of this region, with duplicates of many available for class-work, exchange, etc. A card-catalogue list of state species with faunal and ecological notes is maintained in connection.

The Boston Society of Natural History has recently received the collection of Lepidoptera of the late Howard Lee Clark, which was presented to the Society by Mrs. Clark. The collection contains over 1,100 species represented by 7,200 specimens. The greater part of the collection was made by Mr. Clark on his place at Bristol, R. I. The Noctuidæ, comprising 586 species and over 4,100 specimens, are unusually fine, with a beautiful series of the genus Catocala.

The New York State Museum reports that the most interesting addition to their collection is a series of somewhat over 5,000 specimens, representing probably well over 500 species of insects taken during the summer, on the roof and in the gutters of the Education Building, a location 125 feet above the sidewalk and well above adjacent trees. The data thus secured will give considerable information respecting the flight and seasonal occurrence of a large number of species. The work has also resulted in the capture of a number of unusually interesting or rare forms.

The Iowa State College reports that during the past summer, 1927, a large number of insects, largely Heteroptera, were collected and are being mounted for the college collection. One man spent about two months in the field collecting insects for the college. During the summer of 1926, Carl J. Drake made a collection of insects in California, Oregon, Washington and British Columbia, and will put specimens in the college collection.

Since the report of the University of Nebraska Collection on page 146 of the Annals of Entomological Society of America was published last March, Mr. T. B. Mitchell, of North Carolina State College, working during the summer at the Bussey Institution, identified 3,200 specimens of the bee genus Megachile belonging to the University of Nebraska collection, finding some species new to science and numerous data throwing light on the geographical distribution of the species. This collection, named by Mr. Mitchell, has now been added to the reference series of their collection. Also during the year Dr. C. E. Mickel, of the University of Minnesota, completed the identification of a large series of Mutillidæ of the genera Pseudomethoeca and Dasymutilla belonging to our collection, and these also have been returned and placed in our named reference collection. Mr. Raymond Roberts, an instructor in the Department, has arranged the superfamily Vespoidea, and added considerable new material in that group, while Mr. O. S. Bare has similarly arranged much of the accumulated material in the superfamily Formicoidea and added new material. About one thousand new specimens of Nebraska insects have been added since the last report.

The insect collection of the Illinois State Natural History Survey has been considerably augmented during the past year, the most notable addition being the acquisition of the K. F. Auden collection of insects. This collection, consisting of approximately 9,000 specimens, chiefly of Coleoptera from British Columbia and other parts of North America, was given to the Survey by Mr. Auden's heirs soon after his death in May, 1927. About 6,000 specimens of Illinois insects have been added to the collection by collecting in various parts of the state. Of this number approximately 2,000 specimens are Plecoptera; an insect order heretofore poorly represented in the collection. The Illinois collection of Lepidoptera was strengthened by the donation of Messrs. A. K. Wyatt and E. Beer of 500 well mounted specimens collected in the Chicago area. The collection of Hymenoptera was improved by the gift from Dr. Lewis H. Weld of 160 specimens, including many paratypes, of Cynipidæ and 117 galls caused by them. The typic series was increased by the addition of 134 species, represented by 248 paratypes and three holotypes. Distribution of species of paratypes and holotypes among the various orders was as follows: Orthoptera 2, Odonata 1, Plecoptera 3, Epheme-

rida 3, Homoptera 4, Coleoptera 8, Trichoptera 4, Lepidoptera 1, Diptera 86, and Hymenoptera 25.

During the year 1927 the chief additions to the Cornell University insect collections have been the following: The Leonard collection of 20,000 specimens of Palearctic Pselaphidæ, mostly Balkan; the collection of J. Croissandeau of 1,500 specimens of Pselaphidæ from all regions of the world exclusive of the Palearctic; collections brought from British Guiana and Surinam by Drs. P. P. Babiy and W. T. M. Forbes from a four months' expedition to those countries in the spring of 1927, include approximately 1,600 Orthoptera, 10,000 Lepidoptera (2,000 species), 1,000 Pselaphidæ and 7,500 other orders (excluding perhaps 20,000 unpinned material); a considerable collection of all orders, but especially of aculeate Hymenoptera, from the Western and Southwestern States collected by the Rochester-Cornell Expedition of 1927.

At Ohio State University the most noteworthy addition was in the purchase of the Wenzel collection of Coleoptera, including 100,000 specimens, representing with special fullness the North American species.

The Mississippi A. & M. College reports additions in Coccidæ, Formicidæ and Phyllophaga and that the collection includes type material especially in Coccidæ, Formicidæ, and Phyllophaga.

The Texas A. & M. College collection includes about 2,500 species: Orthoptera 130, Hemiptera 150, Coleoptera 940, Lepidoptera 800, all other orders about 500. The Field Museum, Kansas Agricultural College, Pennsylvania Bureau of Plant Industry, North Carolina Dept. of Agriculture, American Museum of Natural History, Virginia Polytechnic Institute, and the Louisiana State University report usual routine additions or no additions of major importance.

The University of Minnesota reports no outstanding additions have been made to the collection during the past year, although many specimens have been added by local collecting and a few by purchase. The new material added has been principally in the groups Noctuidæ, Mutillidæ, and Thysanoptera. During the past year the following groups have been worked over and determined by specialists: Noctuidæ, Cicindelidæ, Cerambycydæ, Syrphidæ, Silphidæ and the genus Dasymutilla in the Mutillidæ. Papers are in press giving the results of the work on the Cicindelidæ, Silphidæ and the genus Dasymutilla.

Respectfully submitted,

HERBERT OSBORN, *Chairman*,
NATHAN BANKS,
J. G. NEEDHAM,
CHAS. W. JOHNSON.

After some discussion, it was moved by H. E. Ewing, that the name of the Committee on U. S. National Museum be changed to Committee on Collections of Insects in American Museums. Motion carried.

The Committee appointed at the last annual meeting to Study the Poche Propositions in Nomenclature did not present a formal report. The committee included J. Chester Bradley, Chairman, J. M. Aldrich and J. M. Swaine. In a letter dated December 22, 1927, the chairman of the committee reported having followed instructions of the society, as they understood them and had submitted a questionnaire to the members of the Society. The result of this ballot was overwhelmingly against the three propostions in question. A detailed report, a copy of which is in the files of the Secretary, was submitted to the Secretary of the International Commission on Zoological Nomenclature as had been instructed by the Society.

The report was accepted.

After some discussion, it was moved by R. C. Smith and duly seconded that a committee of three be appointed to stablize anatomical terms, it to be known as the Committee on Anatomical Terminology. Motion Carried.

G. C. Crampton, R. E. Snodgrass, and O. A. Johannson, were appointed on this committee.

The Society then adjourned at 3:30 P. M.

In the evening approximately 300 attended the Entomologists' Dinner in the Hotel Hermitage. The dinner was an appreciation to Dr. L. O. Howard and was one of the very best annual dinners ever held.

In addition to the regular program the following exhibits were submitted:

1. "Tarantulas."—Tarantulas in six or more different sizes representing ages from four months to 18 years or older, by W. J. Baerg, University of Arkansas.

2. "Odonata of Hawaiian Islands."—Forty illustrations of the dragonflies of Hawaii, by Clarence H. Kennedy, Ohio State University.

3. "Insects and Mites Affecting Cultivated Mushrooms."—Life histories of the various pests illustrated by specimens and photographs, by Charles A. Thomas, Pennsylvania State College.

Respectfully submitted,

J. J. Davis, Secretary.

THE FOURTH INTERNATIONAL ENTOMOLOGICAL CONGRESS.

Glenn W. Herrick.

The Fourth International Entomological Congress promises to be the most important entomological gathering ever held in this country. We are now assured, I believe, of a good attendance by European entomologists which is the one thing necessary to make it a truly international conference.

The local committee, in consultation with American entomologists in various phases of the science, has formulated a tentative program based largely on the program of the Congress in 1925, at Zurich, Switzerland.

Following the custom of other Congresses and of the Plant Congress held at Ithaca, in 1926, the committee decided that all papers on the program should be by invitation only. In accordance with that plan most of the outstanding foreign entomologists have already been invited and acceptances are slowly coming back to us. The invitations to American entomologists for papers are waiting somewhat on the acceptances of the Europeans, but are being sent out as rapidly as possible in order that everyone will have ample time in which to write a paper. We hope to have a tentative program to present for your information early in the coming year.

Now that we have been given rather satisfactory provision for assuring the presence of foreign entomologists at the Congress we desire to turn our attention to the entomological workers in this country and to urge you to attend and aid in making the Congress a truly great conference. It is your Congress in a larger sense and its success will depend on you and your enthusiasm and presence in

Ithaca from August 12 to the 18th. We are receiving evidence every day of the absorbing interest of foreign entomologists in the work of the American entomologists, and we feel that a really great opportunity has come to us.

We have planned to spend one whole day at the New York Experiment Station, at Geneva, where Mr. Worthley has promised to have a demonstration of airplane dusting, of high power spraying outfits, and of farm machinery used in the clean-up campaign of the European corn-borer. The summer meeting of the New York Fruit Growers will also take place at Geneva on that day, which will afford an example to the foreign visitors of the interest shown by the farmers of this country in entomology.

The question of finances is always an important and insistent one. We are proposing to entertain the foreign visitors while they are here to the extent, at least, of furnishing them with lodging free of cost. In addition we are arranging, if the weather permits, for one or two picnic excursions to some interesting points in the vicinity of Ithaca, which we hope will please all of us. For these projects we shall need money and to meet this need we have appealed to some of the larger and more prosperous entomological societies in the United States and Canada. The response has been very gratifying. The Entomological Society of Philadelphia will, I understand, contribute probably $150.00 or more, while the Ontario Society has already, at least, $100.00 for the cause. Our own little Jugatae has already collected something over $100.00 and other societies are getting actively at work in this direction. We hope this Society and the association of economic entomologists will each contribute a generous amount so that we shall finally have a working capital, if possible, of at least $1000.00.

A final word regarding accommodations, will perhaps interest you. The very attractive women's dormitories, Sage College and Prudence Risley Hall, and the rooms in Cascadilla Hall, have been put at our disposal by the University. In these halls you will find most excellent accommodations at very reasonable rates. In addition, there are many good people in Ithaca who take care of thousands of students during the regular sessions of the University and who will be glad to receive an extra dollar or two from you visiting entomologists and who will in return therefor furnish excellent, quiet, comfortable sleeping quarters. You will also find convenient restaurants, cafeterias, dining-rooms, lunch rooms, quick lunches, all-night lunches and any other variety of food dispensary you desire.

Although the University has never allowed campers on the Campus because of the great American fetish of "Keep off the grass," we hope to find a convenient, suitable field somewhere on the College farm where those who wish can pitch their tents and live in the latest style of the great nomadic throng of gas-engine drivers that crowd the highways and byways of this continent.

I believe we can assure you one and all of comfortable living quarters while you are in Ithaca together with sufficient and nourishing food and we certainly hope you will all come and make this Congress of yours the best that has yet been held.